Dissertation on

METABOLIC SYNDROME IN SUBJECTS WITH TYPE 2 DIABETES MELLITUS

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BONAFIDE CERTIFICATE

This is to certify that this dissertation titled "METABOLIC SYNDROME IN SUBJECTS WITH TYPE-2 DIABETES MELLITUS" is a bonafide work of Dr. K. MALCOLM JEYARAJ, Post Graduate Student in M.D. GENERAL MEDICINE and has been done by him under my direct guidance and supervision, in partial fulfillment of regulations of The Tamilnadu Dr.M.G.R.Medical University, for the award of M.D.Degree in General Medicine during the year 2006.

Prof. Dr. V. UMA DEVI M.D.
Professor and Head
Department of Medicine
Tirunelveli Medical College
Tirunelveli

Place : Tirunelveli - 11
Date :

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INTRODUCTION

Gerald Reaven in the year 1988, reintroduced the concept of Syndrome X for the clustering of cardiovascular risk factors like hypertension, glucose intolerance, high triglycerides and low HDL cholesterol concentrations.[36,58] The syndrome however is much older and has been described by Kylin in the year 1923[36]. He found hypertension, hyperglycaemia and gout to cluster together as a syndrome and such an association has been quoted by researchers subsequently. Clustering analyses have confirmed that these traits occur simultaneously to a greater degree than would be expected by chance alone. [50,51,60,72] Thereafter, several other metabolic abnormalities have been associated with the syndrome, including obesity, microalbuminuria and abnormalities in fibrinolysis and coagulation.[5,28,52,73]

The term metabolic syndrome was coined by German researchers including Haller and colleagues.[3,33,61] In 1991, Ferrannini *et.al.*[23] described the same clustering of abnormalities in this cardiovascular and metabolic syndrome as being caused by insulin resistance and concluded that “insulin resistance syndrome” was the appropriate term for the condition. The metabolic syndrome has also been given other names including the plurimetabolic syndrome and the deadly quartet.[7,15,17,38]

Because of the epidemic of overweight and sedentary lifestyle worldwide, the metabolic syndrome is becoming increasingly common.[71] According to the NCEP definition, roughly one third of middle aged men and women in the United – States have metabolic syndrome.[24] The clinical importance of metabolic syndrome is that it encompasses a cluster of metabolic risk factors associated with an increased risk for type-2 diabetes mellitus and cardiovascular disease.

Most prospective studies have shown that subjects with metabolic syndrome are at an increased risk of incident cardiovascular disease[26,40] and mortality due to cardiovascular disease.[34,35,48] However, many of these studies excluded diabetic patients from their study populations.[26,40] Diabetic patients are at a greater risk for cardiovascular disease than non-diabetic subjects, and it has been suggested that metabolic syndrome is responsible for the increased prevalence of cardiovascular disease seen in diabetic patients.[3] Therefore it is important to evaluate the association of metabolic syndrome according to standard definitions on cardiovascular disease in diabetic patients. Knowledge of such an impact of metabolic syndrome is essential for developing clinical guidelines for its prevention and treatment.

AIMS OF THE STUDY

1. To estimate the prevalence of metabolic syndrome in subjects with type-2 diabetes mellitus in a population of South Tamilnadu using NCEP – ATP III guidelines.

2. To determine the association of metabolic syndrome with cardiovascular (coronary and cerebrovascular) events in these diabetic patients.

3. To determine whether modifications of the above said guidelines are necessary to identify patients with cardiovascular (coronary and cerebrovascular) problems in our population.

REVIEW OF LITERATURE

Metabolic syndrome is characterised by a constellation of metabolic risk factors in one individual.[29,57] The individual components of the metabolic syndrome are complex conditions likely to be underpinned by multiple genetic and environmental causes. That these risk factors should cluster together has been formally confirmed in several large population studies, holding the promise that these diverse conditions may in turn share genetic or environmental causes.

COMPONENTS OF METABOLIC SYNDROME :

The National Cholesterol Education Program, Adult Treatment Panel III,[66] identified 6 components of the metabolic syndrome namely,

- Abdominal obesity
- Atherogenic dyslipidaemia
- Raised blood pressure
- Insulin resistance ± glucose intolerance
- Proinflammatory state
- Prothrombotic state

ABDOMINAL OBESITY :

- Abdominal obesity is the form of obesity most strongly associated with the metabolic syndrome. It presents clinically as increased waist circumference. Further, it has an adverse effect on cardiovascular risk factors such as high blood pressure, high serum cholesterol, low HDL cholesterol and hyperglycaemia.

ATHEROGENIC DYSLIPIDEMIA :

- Atherogenic dyslipidemia manifests in routine lipoprotein analysis by raised triglycerides and low concentrations of HDL cholesterol. A more detailed analysis might reveal other lipoprotein abnormalities eg., increased remnant lipoproteins, elevated apolipoprotein B, small dense LDL particles and small HDL particles. All of these abnormalities have been implicated as being independently atherogenic.

ELEVATED BLOOD PRESSURE :

- Elevated blood pressure is strongly associated with obesity and commonly occurs in insulin resistant persons. Hypertension is listed among metabolic risk factors though being multifactorial in origin.

INSULIN RESISTANCE :

- Insulin resistance is present in the majority of people with the metabolic syndrome. It is strongly associated with other metabolic risk factors and correlates univariately with cardiovascular disease. Patients with longstanding insulin resistance frequently manifest glucose intolerance. When glucose intolerance evolves into diabetes level hyperglycemia, elevated glucose constitutes a major, independent risk factor for cardiovascular disease.

PROINFLAMMATORY STATE :

- A proinflammatory state recognized clinically by elevations of C–reactive protein (CRP) is commonly present in persons with metabolic syndrome. Multiple mechanisms underlie elevations of CRP. One cause is obesity, because excess adipose tissue releases inflammatory cytokines that may elicit higher CRP levels.

PROTHROMBOTIC STATE :

- .A prothrombotic state, characterised by increased plasminogen activator inhibitor (PAI-1) and fibrinogen is associated with metabolic syndrome.

ETIOPATHOGENESIS OF METABOLIC SYNDROME

The metabolic syndrome has three potential etiological categories.[30]

1. Obesity and disorders of adipose tissue
2. Insulin Resistance
3. Constellation of independent factors (eg. molecules of hepatic, vascular and immunologic origin)

1. Obesity and Abnormal Body Fat Distribution :

Adult Treatment Panel III considered the “Obesity epidemic” as mainly responsible for the rising prevalence of metabolic syndrome.

Obesity contributes to hypertension, high serum cholesterol, low HDL cholesterol and hyperglycemia, and it is otherwise associated with higher cardiovascular disease risk. Abdominal obesity especially correlates with metabolic risk factors.

Excess adipose tissue releases several products that apparently exacerbate these risk factors. They include non esterified fatty acids (NEFA), cytokines, PAI-1 and adiponectin. A high plasma NEFA level overloads muscle and liver with lipid, which enhances insulin resistance. High CRP levels accompanying obesity may signify cytokine excess and a proinflammatory state.

An elevated PAI – 1 contributes to a prothrombotic state, whereas low adiponectin levels that accompany obesity correlate with worsening of metabolic risk factors. The strong connection between obesity (especially abdominal obesity) and risk factors led Adult Treatment Panel III to define the metabolic syndrome essentially as a clustering of metabolic complications of obesity.

2. Insulin Resistance :

A second category of causation is insulin resistance.[12,27,41,74] The insulin resistance or its accomplice hyperinsulinaemia, is supposed to directly cause other metabolic risk factors. But, identifying a unique role for insulin resistance in the causation of other risk factors is complicated by the fact that it is linked to obesity.

Though insulin resistance generally rises with increasing body fat content, a broad range of insulin sensitivities exist at any given level of body fat.[1] For eg. most people with categorical obesity (Body mass index [BMI] $\geq$ 30 kg/m^2) have post-prandial hyperinsulinaemia and relatively low insulin sensitivity, but variation in insulin sensitivities exist even within the obese population.

Also, in some populations eg. South Asians, insulin resistance occurs commonly even with body mass index<25 kg/m^2. South Asians and others who manifest insulin resistance with only mild-to-moderate overweight can

be said to have primary insulin resistance. Even with primary insulin resistance, however, weight gain seems to enhance insulin resistance and metabolic syndrome. Thus, dissociation of obesity and primary insulin resistance in-patients with metabolic syndrome is difficult.

Insulin resistance does play a role in the causation of metabolic syndrome. The insulin resistant muscle already overloaded with lipid from high plasma NEFA levels, diverts excess NEFA to liver, promoting fatty liver and atherogenic dyslipidemia. Hyperinsulinaemia may enhance output of very low-density lipoprotein cholesterol, raising triglyceride levels. Insulin resistance in muscle predisposes to glucose intolerance, which can be worsened by increased hepatic gluconeogenesis in insulin resistant liver. Finally, insulin resistance may raise blood pressure by a variety of mechanisms.

3. Independent factors that mediate specific components of the metabolic syndrome :

Beyond obesity and insulin resistance, each risk factor of the metabolic syndrome is subject to its own regulation through both genetic and acquired factors. This leads to variability in expression of risk factors. Lipoprotein metabolism, for instance, is richly modulated by genetic variation, hence expression of dyslipidemias in response to obesity and /or

insulin resistance varies considerably. Similarly blood pressure is also regulated by both genetic and acquired factors. Moreover, glucose levels also depend on insulin secretory capacity as well as insulin sensitivity.

CLINICAL DIAGNOSIS OF METABOLIC SYNDROME :

Many persons seen in clinical practice are readily recognised as having multiple metabolic risk factors.

Clinical studies have noted a high correlation between abdominal obesity and the risk factors characteristic of metabolic syndrome.[6,18,19,30,54] For example, closely associated with abdominal obesity is an elevation of serum trigycerides.[8,37,49] The elevation can be borderline (150-199 mg/dl) or high (>= 200 mg/dl). Similarly, HDL-cholesterol levels <40 mg /dl occur commonly in men with insulin resistance[39] and marginal reductions of HDL-cholesterol levels are observed commonly in women with the syndrome.[53,69] Thus for women, HDL cholesterol <50 mg/dl, would count as one indicator in the diagnosis of metabolic syndrome. A moderately strong association also exists between insulin resistance and hypertension.[44-46]

On the other hand, impaired fasting glucose usually is an indicator of insulin resistance and is frequently accompanied by other metabolic risk

factors,[32,68] hence measurement of fasting glucose in overweight and obese persons is suggested.

A portion of persons with impaired fasting glucose will eventually develop type 2 diabetes[21,47] which further enhances the risk of coronary heart disease. Type 2 diabetes mellitus is the epitome of metabolic syndrome. Other components of the metabolic syndrome (insulin resistance, proinflammatory state and prothrombotic state) cannot be identified by routine clinical evaluation. However, in the presence of abdominal obesity, they are often present.

ATP III CRITERIA FOR CLINICAL DIAGNOSIS OF METABOLIC SYNDROME :

The National Cholesterol Education Programme (NCEP) expert panel on detection, evaluation and treatment of high blood cholesterol in adults (Adult Treatment Panel III) has proposed the following clinical criteria for identification of metabolic syndrome.

ATP III CRITERIA FOR CLINICAL IDENTIFICATION OF METABOLIC SYNDROME :

RISK FACTORS	DEFINING LEVEL
Abdominal obesity, given as waist circumference Men Women	 > 102 Cm (> 40 in) > 88 Cm (> 35 in)
Triglycerides	≥ 150 mg/ dl
HDL cholesterol Men Women	 < 40 mg / dl < 50 mg / dl
Blood Pressure	≥ 130 / ≥ 85 mm Hg
Fasting Glucose	≥ 110 mg / dl

When 3 of the 5 listed characteristics are present, a diagnosis of metabolic syndrome can be made.

Cutoff points for several of these are less stringent than usually required to identify a categorical risk factor, because multiple marginal risk factors can import significantly increased risk for cardiovascular disease.[33]

Overweight and obesity are associated with insulin resistance and metabolic syndrome. However the presence of abdominal obesity is more highly correlated with metabolic risk factors than is an elevated body mass

index. Therefore, the simple measure of waist circumference is recommended to identify the body weight component of the metabolic syndrome.[33]

The Adult Treatment Panel III panel did not find adequate evidence to recommend routine measurement of insulin resistance (eg. plasma insulin), proinflammatory state (eg. high sensitivity C-reactive protein), or prothrombotic state (eg. fibrinogen or PAI-1) in the diagnosis of metabolic syndrome.[66]

Some male patients can develop multiple metabolic risk factors when the waist circumference is marginally increased (eg. 94-102 cm) (37 to 39 inches). Such patients may have a strong genetic contribution to insulin resistance. They should benefit from lifestyle changes, similar to men with categorical increases in waist circumference.[66]

The presence of type 2 diabetes mellitus does not exclude a diagnosis of metabolic syndrome.[30]

METABOLIC SYNDROME AS A PREDICTOR OF DIABETES :

The Framingham investigators examined their extensive database for the relation between metabolic syndrome and future development of both diabetes and cardio vascular disease.[30] Their analysis was carried

out on 3323 Framingham offspring men and women in 8 years of follow up.

They found out that metabolic syndrome was highly predictive of new onset diabetes mellitus and nearly half of the population attributable risk for diabetes could be explained by the presence of Adult Treatment Panel III criteria for metabolic syndrome.

DIABETES AS A PREDICTOR OF CARDIOVASCULAR DISEASE :

Cardiovascular disease is increased in individuals with type-2 diabetes mellitus. The Framingham study revealed a marked increase in peripheral arterial disease, coronary artery disease, myocardial infarction and sudden death in subjects with type-2 diabetes mellitus. Type-2 diabetic patients without a prior myocardial infarction have a similar risk for coronary artery related events as non-diabetic individuals who have had a prior myocardial infarction.

The increase in cardiovascular morbidity and mortality appears to be related to the synergism of hyperglycaemia with other cardiovascular risk factors.

METABOLIC SYNDROME AS A PREDICTOR OF CARDIOVASCULAR DISEASE IN DIABETIC INDIVIDUALS:

The clinical importance of metabolic syndrome is related to its putative impact on cardiovascular morbidity and mortality.

Most prospective studies have shown that subjects with metabolic syndrome are at an increased risk of incident cardiovascular disease[40] and mortality due to the same. However, many of these studies excluded diabetic patients from their study populations.[26,40] Diabetic populations are known to be at a greater risk for cardiovascular disease than non-diabetic subjects, and it has been suggested that metabolic syndrome is responsible for the increased prevalence of coronary heart disease seen in diabetic patients.[3] Therefore it is important to evaluate the association of metabolic syndrome with cardiovascular disease in diabetic subjects using the commonly used National Cholesterol Education Programme Adult Treatment Panel III guidelines for metabolic syndrome.

MANAGEMENT OF UNDERLYING RISK FACTORS :

The underlying risk factors that promote the development of metabolic syndrome are overweight and obesity, physical inactivity and an atherogenic diet. The current guidelines on the management of individual components of the metabolic syndrome emphasize life style modification as first line therapy. Adult Treatment Panel III introduced the concept of

metabolic syndrome into its cholesterol guidelines in an attempt to highlight the need for more intensive life style therapy as a means to prevent cardiovascular disease in higher-risk patients. Drug therapy is considered secondary.[31]

OVERWEIGHT AND OBESITY :

Abdominal obesity, [defined as waist circumference > 102 cm (40 inches) in men and >88cm (35 inches) in women] is identified with several components of the metabolic syndrome. Adult Treatment Panel III recommended that abdominal obesity be considered one of the risk factor for metabolic syndrome. Individuals can have metabolic syndrome with a lesser degree of or no abdominal obesity if three of the remaining components are found.[31]

Obesity guidelines[13] stress the need for weight reduction using behavioural change to reduce caloric intake and increase physical activity.

For long term weight loss reduced-energy diets, consisting of modest 500 to 1000 calorie/ day reduction is effective. The realistic goal for weight reduction is to reduce body weight by around seven to ten percent over a period of six to twelve months. Long term maintenance of weight loss is best achieved when regular exercise is included in the weight-reduction regimen.

The other factors that should be emphasised include improvements in eating habits, social support, stress management and a regular exercise regimen. Professional support in the form of nutrition counselling would also be helpful.

PHYSICAL INACTIVITY :

Regular exercise and fitness improve several metabolic risk factors and are associated with a reduction in the risk of developing many chronic diseases.[57] Hence physical inactivity is considered to be an important contributor to the development of metabolic syndrome.

The current physical activity guidelines[2,16,67] recommend practical, regular and moderate regimens for exercise. The standard exercise recommendation is a daily minimum of thirty to forty five minutes of moderate intensity physical activity. The entire duration of physical activity should include a warm up phase of five to ten minutes, aerobic phase of twenty to thirty minutes and cool down phase of 5 to 10 minutes at the end. Increasing the level of physical activity enhances the beneficial effect.

Incorporating multiple short (10 to 15 minutes) bouts of activity (brisk walking), avoiding common sedentary activities in leisure time (television watching), adding regular exercise into daily schedule (eg. brisk walking, jogging, team sports) and self monitoring of exercise are some of the recommendations for physical activity.

Physical inactivity and metabolic syndrome are closely interrelated. Hence management of metabolic syndrome should include initiation of a program of regular physical activity. Physical activity is one modality associated with successful weight reduction. The combination of weight reduction program with increased physical activity can halve the progression to new-onset diabetes over a period of several years in persons with prediabetes which is defined as impaired fasting glucose (IFG) or impaired glucose tolerance (IGT).[31]

The favourable effect of weight reduction and exercise on cardiovascular disease risk factors provides strong support and justification for recommending them as part of a regimen to reduce risk for the same.

DIETARY MODIFICATION :

Adult Treatment Panel III recommendations for diet composition of patients with metabolic syndrome include low intake of saturated fats and cholesterol; reduced consumption of simple sugar and increased intake of fruits, vegetables and whole grains.[4,31,42] The clinical significance of diet induced atherogenic dyslipidemia is undetermined.

Recent small clinical trials indicate that improvement of atherogenic dyslipidemia by increasing unsaturated fat consumption is relatively small when compared with standard dietary recommendations.[4,42]

MEDICAL MANAGEMENT OF METABOLIC RISK FACTORS :

Therapeutic life style modification is the first line therapy for metabolic syndrome, though drug therapy may be necessary in many patients to achieve the recommended goals.

ATHEROGENIC DYSLIPIDEMIA :

HMGCo-A reductase inhibitors reduce all apolipoprotein B containing lipoproteins and can achieve the ATP III goals for LDL cholesterol as well as for non HDL cholesterol.[3]

Fibrates improve all components of atherogenic dyslipidemia and also appears to reduce the risk for cardiovascular disease.

Fibrates in combination with statins is effective, though the risk of myopathy is increased.[55]

Fenofibrate does not interact adversely with statin catabolism and thus may be safe to use in combination therapy.

Nicotinic acid has similar features to fibrates and the combination of nicotinic acid and statins is promising. Nicotinic acid is supposed to be effective in raising HDL cholesterol levels, but higher doses may raise plasma glucose levels.

ELEVATED BLOOD PRESSURE :

Blood pressure $\geq$ 130 / $\geq$ 85 mm Hg is one of the risk factor defining levels in metabolic syndrome. In-patients with categorical hypertension (blood pressure $\geq$ 140 / $\geq$ 90 mm Hg) drug therapies are required according to Joint National Committee 7[14] recommendations. In patients with established diabetes mellitus, antihypertensives should be introduced at even lower blood pressures ($\geq$ 130 / $\geq$ 80 mm Hg)

No class of antihypertensive drug has been identified as being uniquely efficacious in patients with metabolic syndrome.

INSULIN RESISTANCE AND HYPERGLYCAEMIA :

There is a possibility in that, the drugs that reduce insulin resistance will delay onset of type-2 diabetes mellitus and reduce the cardiovascular risk when metabolic syndrome is present. The diabetes prevention program showed that metformin therapy in patients with prediabetes will prevent or delay the development of diabetes.[31]

Troglitazone had also been suggested with a similar effect but has been withdrawn from commercial use.

Insulin resistance is associated with an increased cardiovascular disease risk, but neither metformin nor thiazolidinediones have been shown to reduce the risk in those persons with metabolic syndrome, prediabetes or diabetes. Thus there is insufficient evidence to recommend these drugs for anything other than their glucose – lowering action.

The presence of metabolic syndrome in patients with type 2 diabetes mellitus conveys a particularly high risk for cardiovascular disease. When both are present appropriate treatment of dyslipidemia and hypertension is essential. Good glycaemic control is also essential as it will reduce cardiovascular disease events. Choice of drug therapy to achieve glycaemic control is based on clinical judgement.[31]

PROINFLAMMATORY STATE :

Proinflammatory state is characterised by elevated cytokines (eg. tumor necrosis factor - $\propto$ and interleukin – 6) as well as by elevations in acute phase reactants (CRP and fibrinogen). Measurement of CRP (C-reactive protein) is the most practical way to assess the presence of an inflammatory state CRP levels tend to be higher than normal level in patients with metabolic syndrome.[31]

An elevated CRP ($\geq$ 3 mg / 1ml) is an emerging risk factor for cardiovascular disease. American Heart Association and Centre for Disease Control (CDC) have issued guidelines for the measurement of CRP in clinical practice. The testing should be limited to individuals assessed to be at an intermediate risk by Framingham scoring. The purpose of determining CRP levels in an intermediate risk patient is to find out those with higher CRP levels so that they may be placed in a higher risk category.[31]

The practical consequences of elevating the risk category would be to intensify life style therapies and make certain that low dose aspirin is used.

PROTHROMBOTIC STATE :

The prothrombotic state in patients with metabolic syndrome is characterised by elevations of fibrinogen, plasminogen activator inhibitor - 1 and possibly other coagulation factors. These factors are not measured routinely in clinical practice.

The risk for thrombotic events can be reduced by aspirin therapy. The American Heart Association currently recommends use of aspirin prophylaxis in most patients whose 10 year risk for coronary heart disease is $\geq$ 10% as determined by Framingham risk scoring.[31]

Including patients with metabolic syndrome when their 10 year risk for coronary heart disease is < 10% is appropriate.

MATERIALS AND METHODS

The study was conducted on all patients attending the diabetic clinic at Government Tirunelveli Medical College Hospital during the year 2005. This is an observational clinical study. It was done prospectively. It was a one point in time study.

The study population consisted of all patients with type-2 diabetes mellitus diagnosed according to the WHO-criteria.[70] Patients taking anti-diabetic and anti-hypertensive agents were also included in the study. Gestational diabetics and patients with chronic renal failure were not included in the study. A total of 110 patients were screened, 10 patients were excluded, seven of them were type 1 diabetics and three suffered from chronic renal failure.

A detailed proforma was prepared which included details regarding food habits, literacy status, occupation, annual income and clinical features at the time of presentation.

Weight in kilograms (measured in light clothing without shoes/slippers), height, body mass index (BMI) defined as weight in kg by square of the height in metres,[25] waist circumference was calculated as the average of two measurements taken after inspiration and expiration at the

midpoint between the lowest rib and iliac crest,[43] hip circumference was measured at the level of greater trochanter[43] and waist hip ratio was calculated. Two blood pressure recordings were obtained from the right arm of patients in a sitting posture after 10 minutes of rest at 5 minutes intervals and their mean value was calculated. Blood pressure was also recorded in the standing posture.

Biochemical variables :

Venous blood was drawn after an overnight fast and before the administration of any antidiabetic medications[25].

Biochemical Methods :

Measurement of lipid profile and glucose were made with Transasia ERBA XL-300 auto analyser.

The National Cholesterol Education Program, Adult Treatment Panel III criteria for diagnosis of metabolic syndrome was used in all patients. Cardiovascular end points included either coronary or cerebrovascular events. Coronary end points were defined as those experiencing typical chest pain or having a previous history of myocardial infarction as validated by changes in a 12-lead electrocardiogram. Cerebrovascular end

points included stroke and transient ischaemic attacks. Stroke events were defined as a constellation of focal or global neurologic deficits of sudden or rapid onset and for which there was no apparent cause other than a vascular accident,[62] as determined by history and neurological examination.

However there were certain limitations to the study, wherein coronary heart disease was diagnosed only on the basis of history, physical examination and electrocardiogram and not on the basis of coronary angiography. This is expected to decrease the sensitivity of detecting coronary heart disease. Cerebrovascular involvement was similarly studied on the basis of detailed history and physical examination only. It is understood that they are only a subjective assessment, though they were done in great detail. Cerebrovascular involvement was similarly studied on the basis of detailed history and physical examination only. It is understood that they are only a subjective assessment, though they were done in great detail.

Statistical Analysis :

The results are inferred on the basis of statistical tools viz. ‘Z’ test, students ‘t’ test, association of attributes (Q) and odd’s ratio (O.R.) for attributable risk.

OBSERVATION AND RESULTS

The study was done on patients attending diabetic clinic at Government Tirunelveli Medical College, Hospital. The study was a prospective one. A total of 100 patients were selected as study subjects.

Out of the 100 cases, 62 were males and 38 were females.

Table 1 : Age and sex-wise distribution of subjects

Age group	Male	Female	Total
30 – 39	1	2	3
40 – 49	15	6	21
50 – 59	26	14	40
60 – 69	14	13	27
70 – 79	6	3	9
Total	62	38	100
Mean	56.5	57.4	56.8
S.D.	9.5	9.8	9.6

$Z = 0.452$; $p > 0.05$

Table 1 illustrates the age and sex-wise distribution of the study subjects. The mean age of the male subjects were 56.5 ± 9.5 and the mean age of the female subjects were 57.4 ± 9.8. The mean age of the study population is 56.8 ± 9.6. The mean ages of the male and female sub-groups were comparable and the difference is not statistically significant ($p>0.05$).

Fig.1. Age and sex-wise distribution of subjects

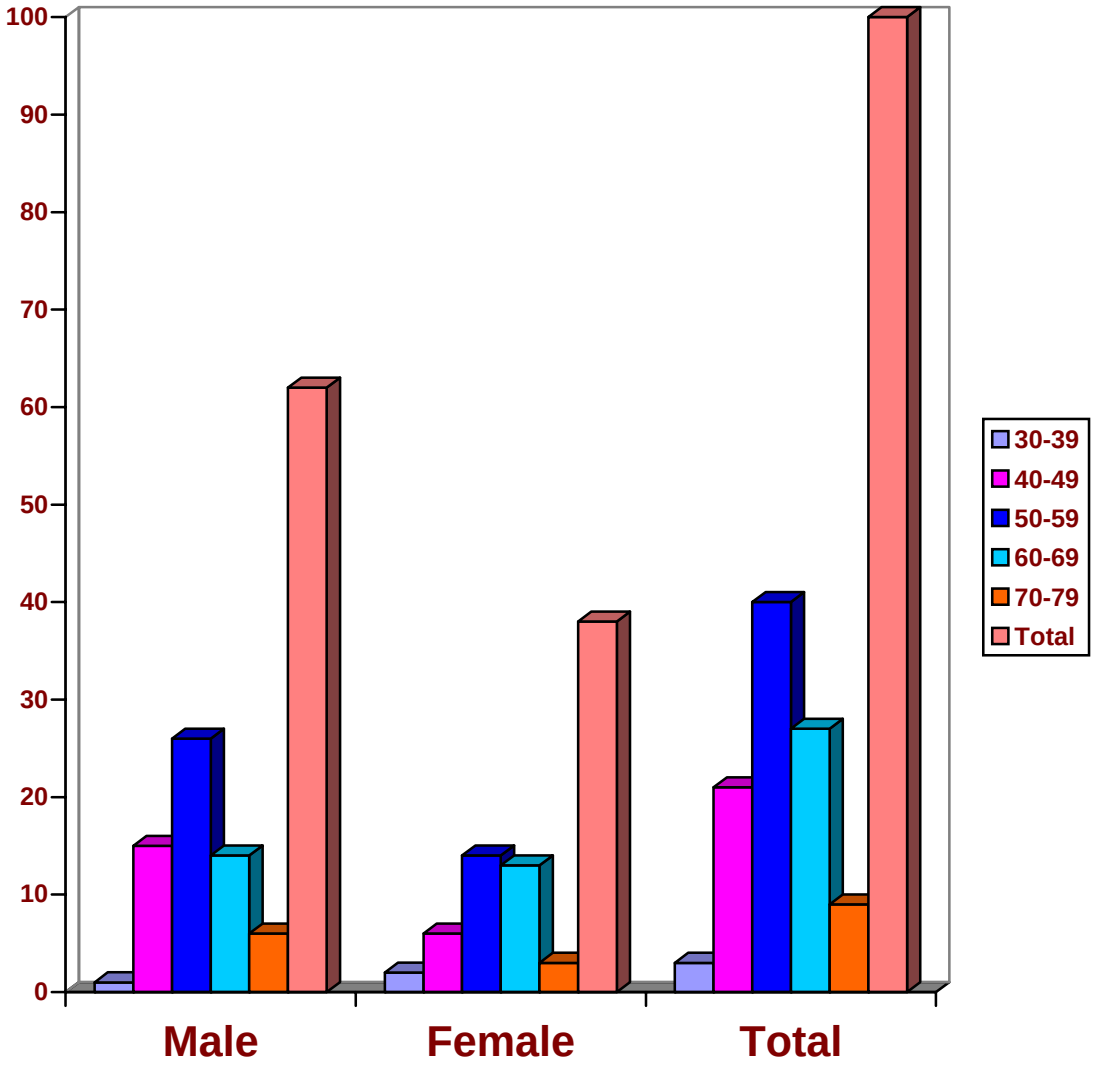


Table 2 : Age, sex and metabolic syndrome wise distribution

Age group	Male		Female		Total	
	M.S. +	M.S. -	M.S. +	M.S. -	M.S. +	M.S. -
30 – 39	0	1	1	1	1	2
40 – 49	9	6	3	3	12	9
50 – 59	14	12	6	8	20	20
60 – 69	6	8	10	3	16	11
70 – 79	4	2	3	0	7	2
Total	33	29	23	15	56	44
Mean	55.3	56.4	59.8	53.7	57.9	55.5
S.D.	9.7	9.4	10.2	8.1	9.9	10.9
Significance	$Z = 0.45$ $p > 0.05$		$Z = 2.0$ $p < 0.05$		$Z = 1.13$ $p > 0.05$	

Table 2 explains the age and sex-wise distribution of cases with and without metabolic syndrome.

In the male subgroup the mean age of cases with metabolic syndrome is 55.3 ± 9.7 and the mean age of cases without metabolic syndrome is 56.4 ± 9.4. The mean ages of cases with and without metabolic syndrome were compared and the difference is not statistically significant ($p > 0.05$).

In the female sub-group the mean age of cases with metabolic syndrome is 59.8 ± 10.2 and the mean age of cases without metabolic syndrome is 53.7 ± 8.1. The difference between the mean ages of the above group is statistically significant, ($p < 0.05$)

The prevalence of metabolic syndrome among males is 53.2% and among females is 60.5%. The difference is not statistically significant ($p>0.05$). The total prevalence of metabolic syndrome among subjects with type-2 diabetes mellitus is 56%.

Fig.2. Age, sex and metabolic syndrome wise distribution of subjects

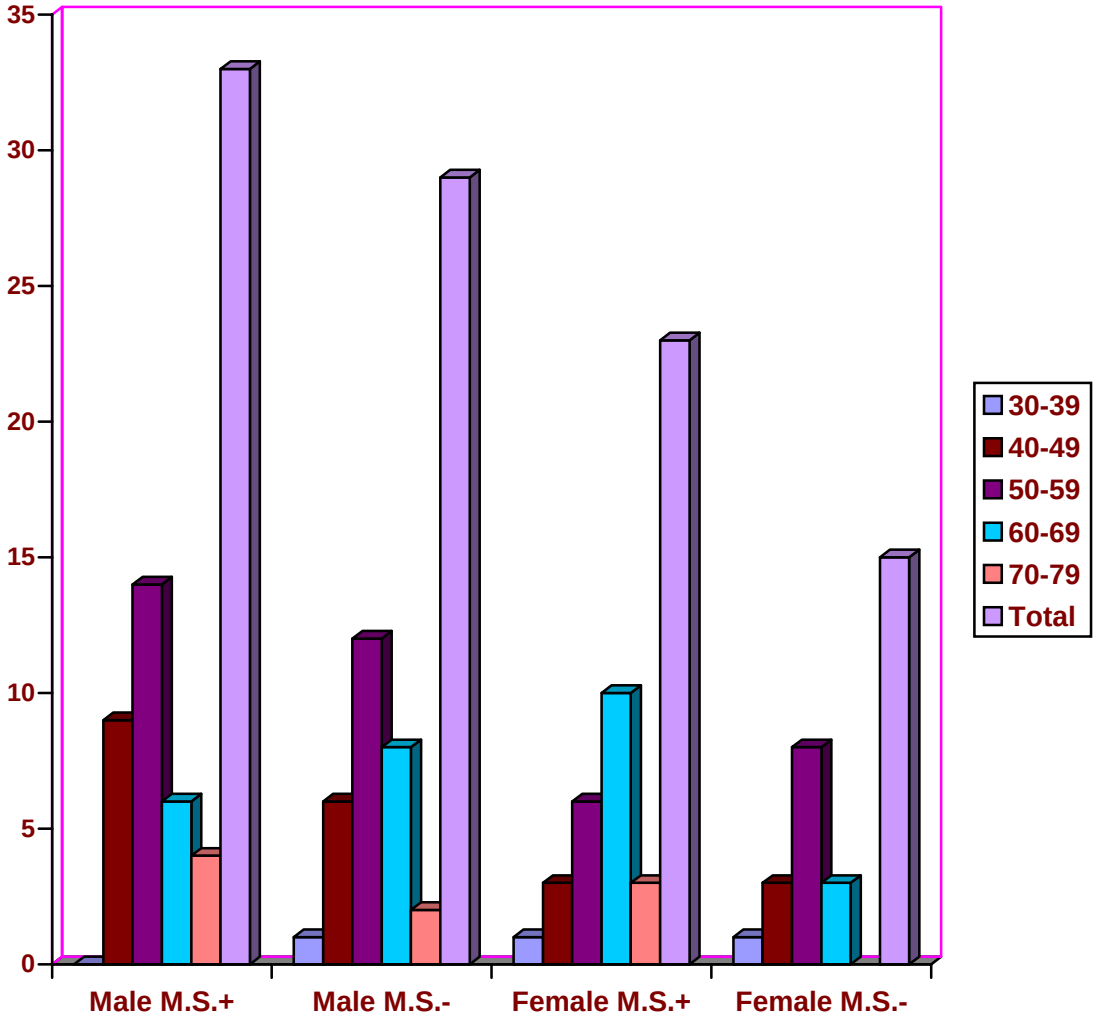


Table 3 : Male subjects classified according to the presence and absence of metabolic syndrome and cardiovascular disease.

Age group	M.S. +		M.S. -		Total	
	CVD +	CVD -	CVD +	CVD -	CVD +	CVD -
30 – 39	0	0	1	-	1	-
40 – 49	1	8	2	4	3	12
50 – 59	4	10	7	5	11	15
60 – 69	4	2	4	4	8	6
70 – 79	1	3	0	2	1	5
Total	10	23	14	15	24	38
Mean	60.0	55.0	55.0	57.7	57.1	56.1
S.D.	8.1	9.8	7.6	10.0	8.7	9.9
Significance	t = 1.29 p > 0.05		t = 0.73 p > 0.05		z = 0.02 p > 0.05	

Among males, age group wise presence and absence of cardiovascular disease in subjects with and without metabolic syndrome are shown in Table 3.

The mean age of male subjects with metabolic syndrome and cardiovascular disease was 60.0 $\pm$ 8.1 and the mean age of male subjects with metabolic syndrome and without cardiovascular disease was 55 $\pm$ 9.8. The observed difference between the mean age of the male and female subjects is statistically insignificant ($p>0.05$).

Similarly, among male subjects without metabolic syndrome, the mean age of subjects with cardiovascular disease was 55 $\pm$ 7.6 and the mean age of subjects without cardiovascular disease was 57.7$\pm$7.6 and the difference in the mean ages is statistically insignificant ($p>0.05$).

Fig.3. Male subjects classified according to the presence and absence of metabolic syndrome and cardiovascular disease.

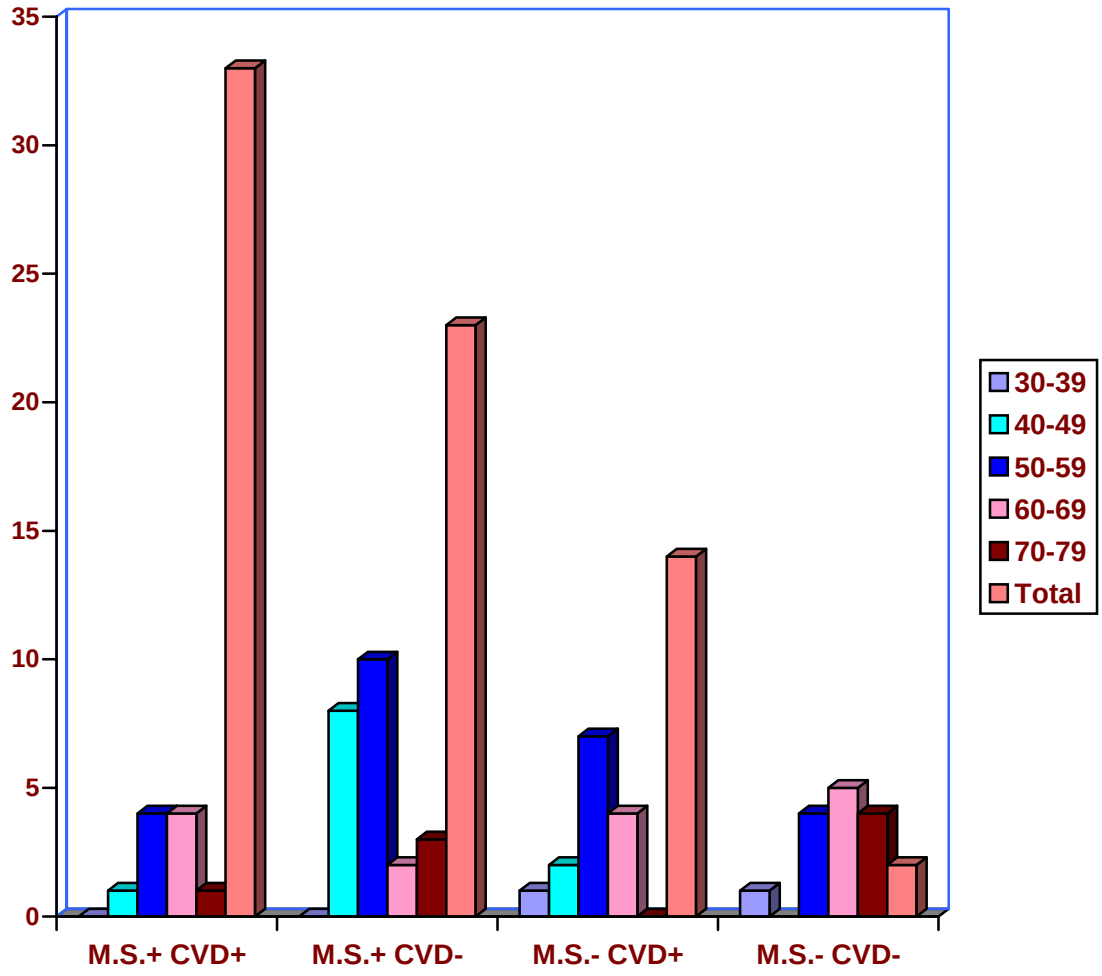


Table 4 : Female subjects classified according to the presence and absence of metabolic syndrome and cardiovascular disease.

Age group	M.S. +		M.S. -		Total	
	CVD +	CVD -	CVD +	CVD -	CVD +	CVD -
30 – 39	0	1	1	0	1	1
40 – 49	1	2	1	2	2	4
50 – 59	3	3	3	5	6	8
60 – 69	6	4	1	2	7	6
70 – 79	2	1	0	0	2	1
Total	12	11	6	9	18	20
Mean	62.5	56.8	51.7	55.0	61.2	56.5
S.D.	8.3	11.1	9.4	6.6	10	9.4
Significance	t = 1.72 ; p > 0.05		t = 0.71 ; p > 0.05		t = 1.33 ; p > 0.05	

Female subjects classified age-wise according to the presence or absence of metabolic syndrome and cardiovascular disease, are displayed in Table 4.

The mean age of female subjects with metabolic syndrome and cardiovascular disease is 62.5 $\pm$ 8.3. The mean age of female subjects with metabolic syndrome and without cardiovascular disease is 56.8 $\pm$ 11.1. The difference between the mean ages is statistically insignificant (p>0.05)

In subjects without metabolic syndrome, the difference between the mean ages of cases with cardiovascular disease (51.7±9.4) and without cardiovascular disease (55±6.6) is statistically insignificant ($p>0.05$).

Fig.4. Female subjects classified according to the presence and absence of metabolic syndrome and cardiovascular disease.

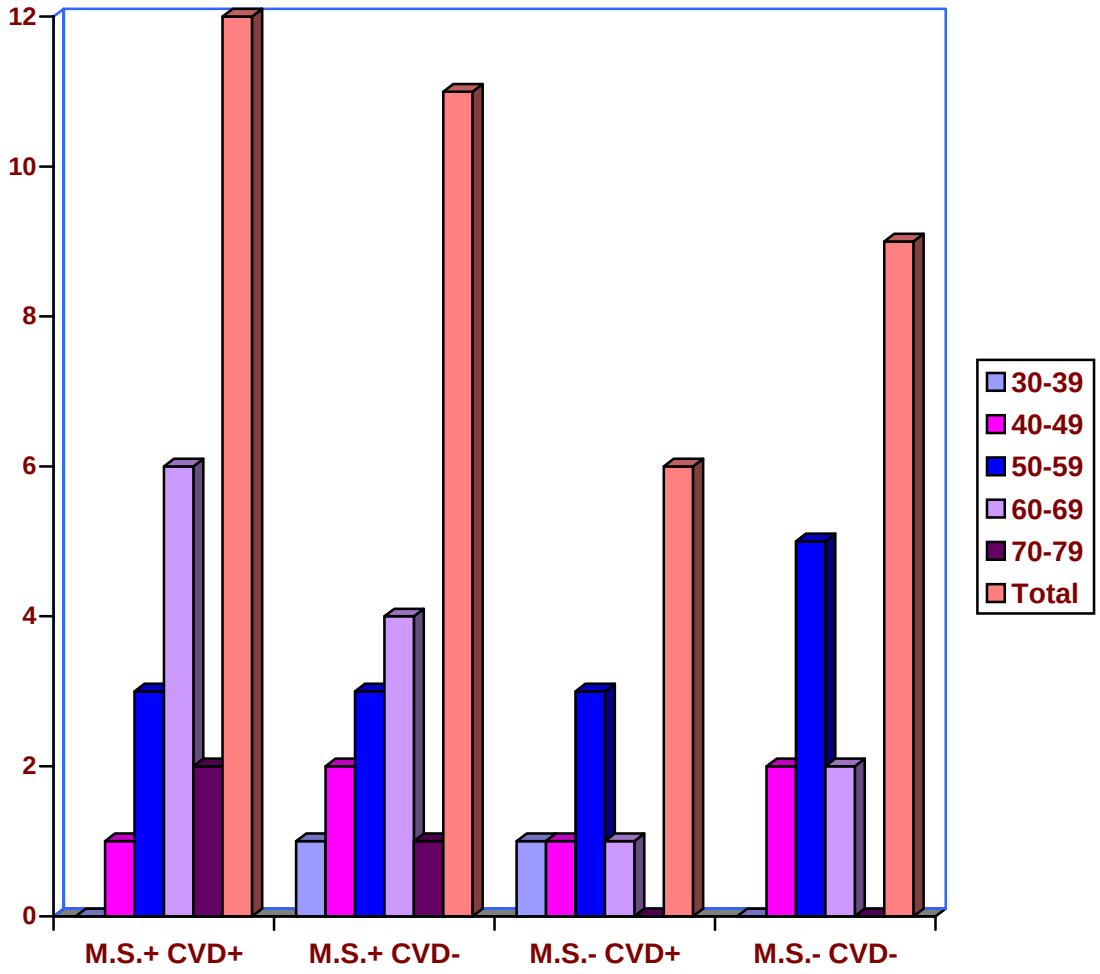


Table 5 : Percentage distribution of sex wise cardiovascular disease (CVD) cases with and without metabolic syndrome (MS)

Sex	% of CVD with MS	% of CVD without MS	Significance
Male	30.3 (10)	48.3 (14)	p > 0.05
Female	52.2 (12)	40.0 (6)	p > 0.05
TOTAL	39.3 (22)	45.5 (20)	p > 0.05

Table 5 shows the percentage wise distribution of cardiovascular disease in subjects with and without metabolic syndrome. Sex wise prevalence was also assessed.

When compared the observed differences in the percentage distribution of cardiovascular disease cases with and without metabolic syndrome were statistically insignificant (p>0.05)

Table 6 : Comparison of mean ages of cardiovascular disease cases with and without metabolic syndrome in male subjects

	MALE	
	CVD +	
	MS +	MS -
Mean	60.0	55.0
S.D.	8.1	7.6
η	10	14
SIGNIFICANCE	t = 1.39 ; p > 0.05	

Table 6, shows the mean ages of male cardiovascular disease subjects with and without metabolic syndrome.

The mean age of those with metabolic syndrome is 60.0 ± 8.1 and the mean age of those without metabolic syndrome is 55.0 ± 7.6.

Eventhough there is an observed difference of 5 years, this difference is not statistically significant ($p>0.05$). Hence, age does not play any role in the occurrence of cardiovascular disease in male subjects with and without metabolic syndrome.

Fig.5. Comparison of mean ages of cardiovascular disease cases with and without metabolic syndrome in male subjects

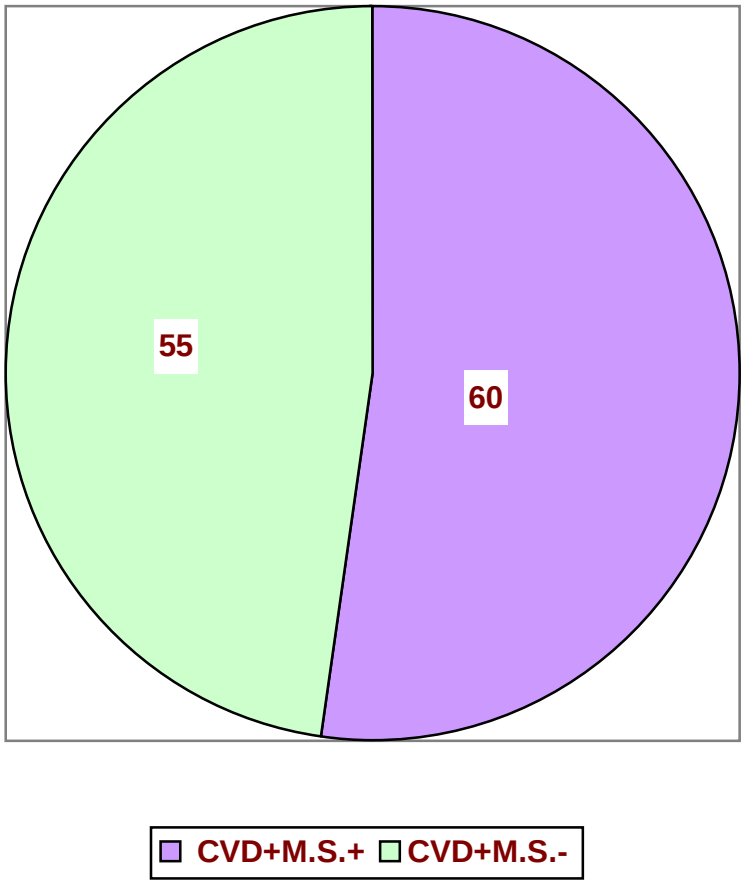


Table 7 : Comparison of mean ages of cardiovascular disease cases in female subjects with and without metabolic syndrome

	FEMALE	
	CVD +	
	MS +	MS -
Mean	62.5	51.7
S.D.	8.3	9.4
η	12	6
Significance	t = 2.23 ;	p < 0.05

The mean ages of female cardiovascular disease subjects with and without metabolic syndrome are displayed in Table 7.

The mean age of female cardiovascular disease subjects with metabolic syndrome is 62.5 $\pm$ 8.3 and the mean age of those without metabolic syndrome is 51.7 $\pm$ 9.4.

The observed difference is nearly ten years and the difference is statistically significant ($p<0.05$).

Fig.6. Comparison of mean ages of cardiovascular disease cases with and without metabolic syndrome in female subjects

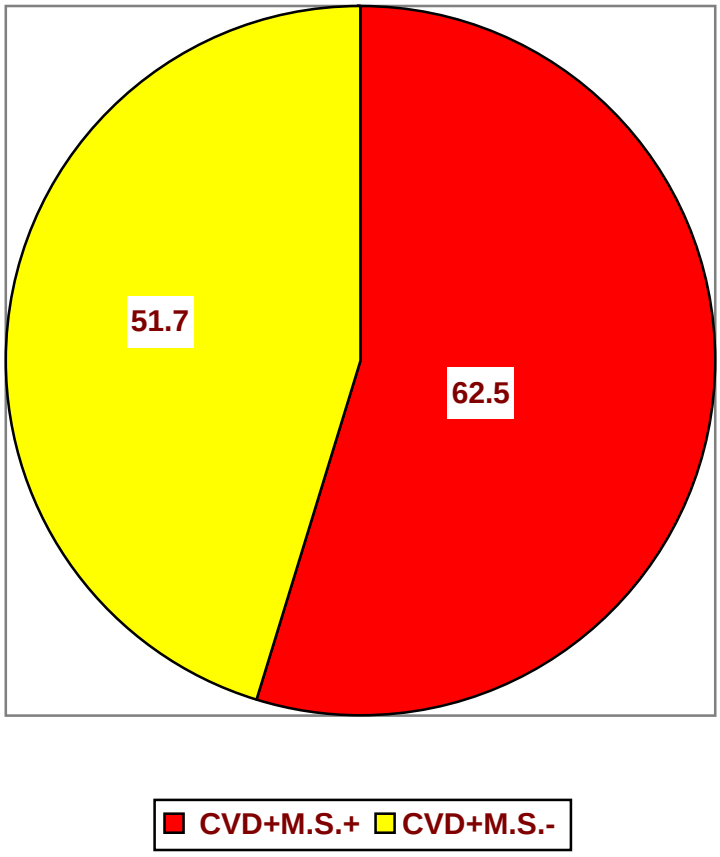


Table 8 : Association of male cardiovascular disease cases with and without metabolic syndrome

	M.S.$^{+}$	**M.S.$^{-}$**
CVD +	**10 (30.3%)**	**14 (48.3%)**
CVD -	23 (69.7%)	15 (51.7%)
	Q = - 0.364 ; O.R. = 0.466	

Table 8 illustrates the association of cardiovascular disease in subjects with and without metabolic syndrome among males.

Among 33 male metabolic syndrome subjects, cardiovascular disease was present in 10 (30.3%) and not present in the remaining 23 (69.7%) subjects. Out of the 29 subjects without metabolic syndrome 14 subjects (48.3%) had cardiovascular disease and the remaining 15 (51.7%) subjects were not found to have cardiovascular disease.

The risk of association of metabolic syndrome with cardiovascular disease is very low (O.R. = 0.466).

Hence, it can be inferred that metabolic syndrome does not play a very important role in predicting cardiovascular disease in males.

Fig.7. Association of male cardiovascular disease cases with and without metabolic syndrome

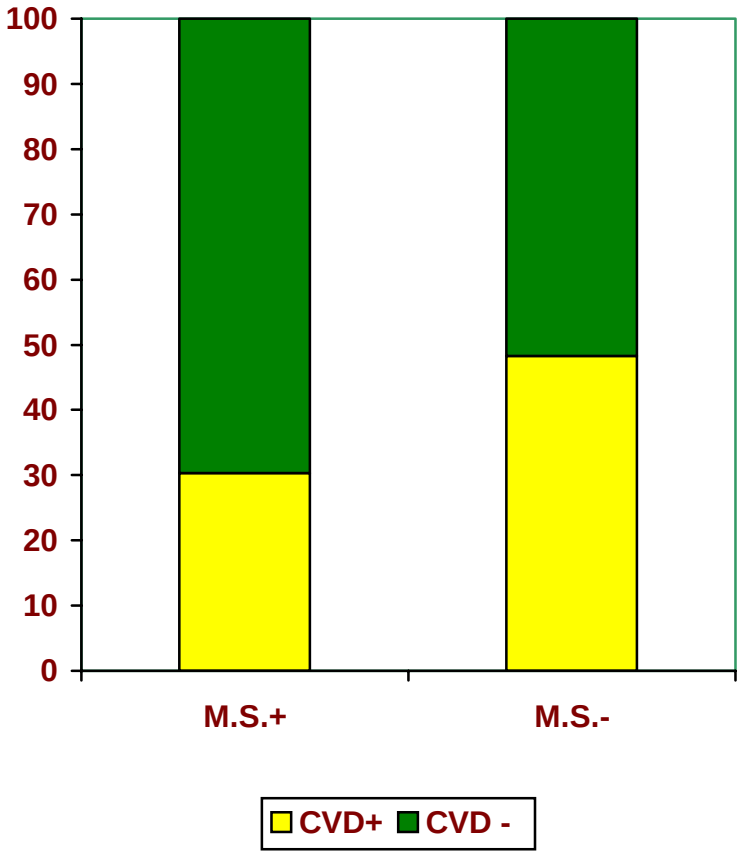


Table 9 : Association of female cardiovascular disease cases with and without metabolic syndrome

	M.S.$^{+}$	**M.S.$^{-}$**
CVD +	**12 (52.2%)**	**6 (40%)**
CVD -	11 (47.8%)	9 (60%)
	Q = 0.241 ; O.R. = 1.6	

Association of cardiovascular disease in female subjects with and without metabolic syndrome is explained in Table 9.

Among 23 female subjects with metabolic syndrome 12 (52.2%) had cardiovascular disease, while 11 (47.8%) did not suffer from the same. In female subjects without metabolic syndrome, cardiovascular disease was present in 6 (40%) while it was absent in 9 (60%).

The risk of association of metabolic syndrome with cardiovascular disease is high in females (Odds Ratio =1.6)

Hence, metabolic syndrome is found to be useful in predicting cardiovascular disease in female patients.

Fig.8. Association of female cardiovascular disease cases with and without metabolic syndrome

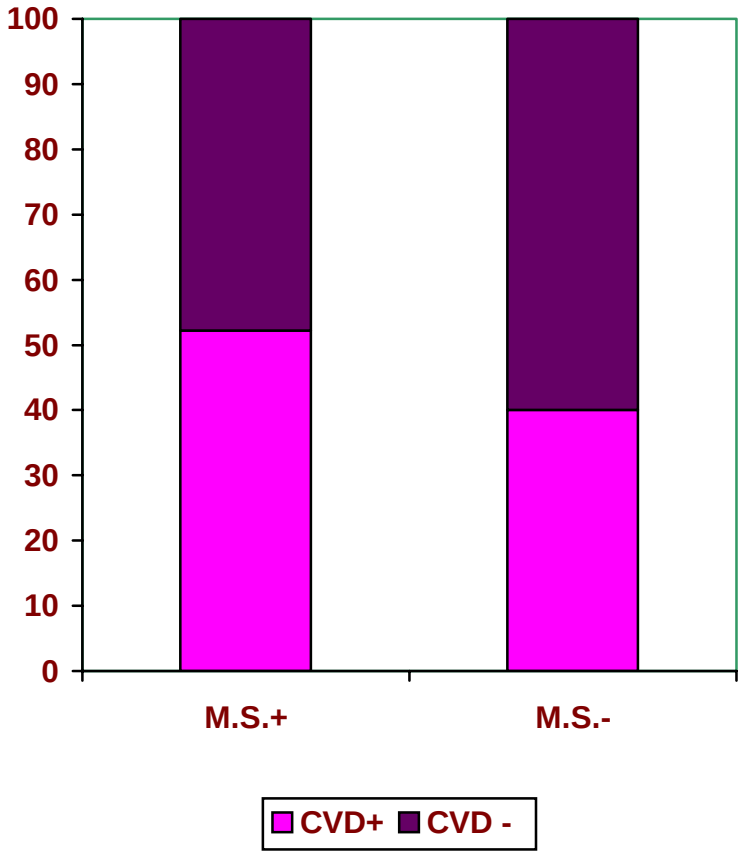


Table 10 : Association of cardiovascular disease with blood pressure in male and female subjects

	MALE		FEMALE	
	≥ 130 / 85	**< 130 / 85**	**≥ 130 / 85**	**< 130 / 85**
CVD +	**17**	**7**	15	3
CVD -	24	14	8	12
	Q = 0.1724 ; O.R. = 1.35		Q = 0.764 ; O.R. = 7.5	

The association between cardiovascular disease and blood pressure of male and female subjects are furnished in the above table.

As seen in Table 10, there is an association within the male population between elevated blood pressure and cardiovascular disease. The risk of elevated blood pressure is 1.35 times. Similarly, among the female population, elevated blood pressure is highly associated with cardiovascular disease (O.R.=7.5).

The mean elevated systolic blood pressure (≥ 130mmHg) in males is 142.4 ± 13.6 and 155 ± 23.1 in females. The difference of mean elevated systolic blood pressure is statistically significant ($p < 0.05$).

The mean elevated diastolic blood pressure (≥ 85 mmHg) in males is 94.4 ± 7.1 and in females is 96.6 ± 9.0. The difference is not statistically significant ($p>0.05$).

Fig.9.a. Percentage association of cardiovascular disease with blood pressure (Males)

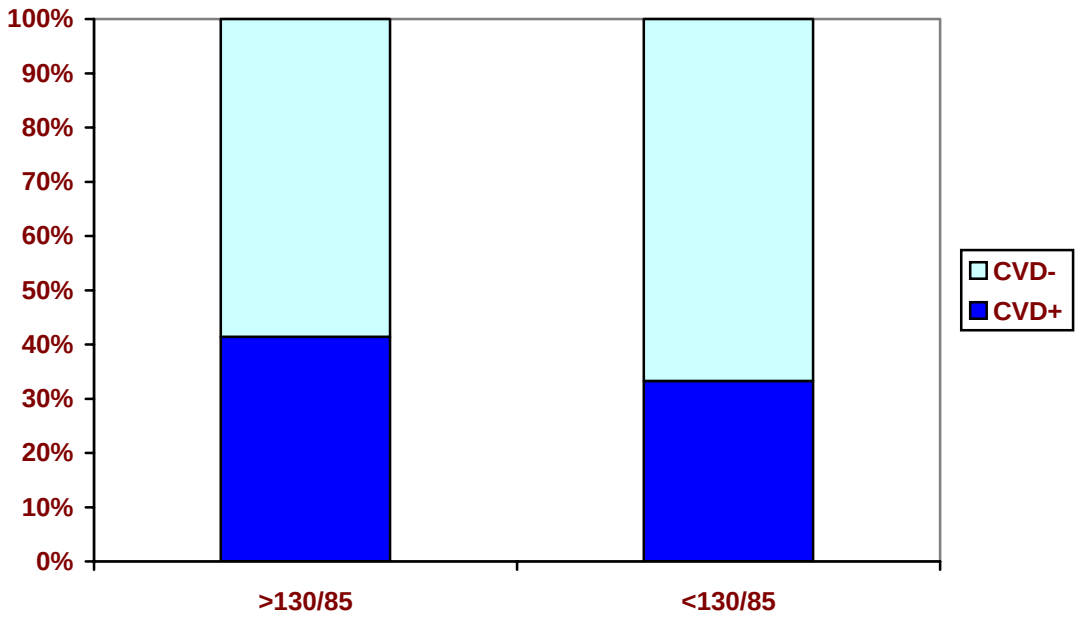


Fig.9.b. Percentage association of cardiovascular disease with blood pressure (Females)

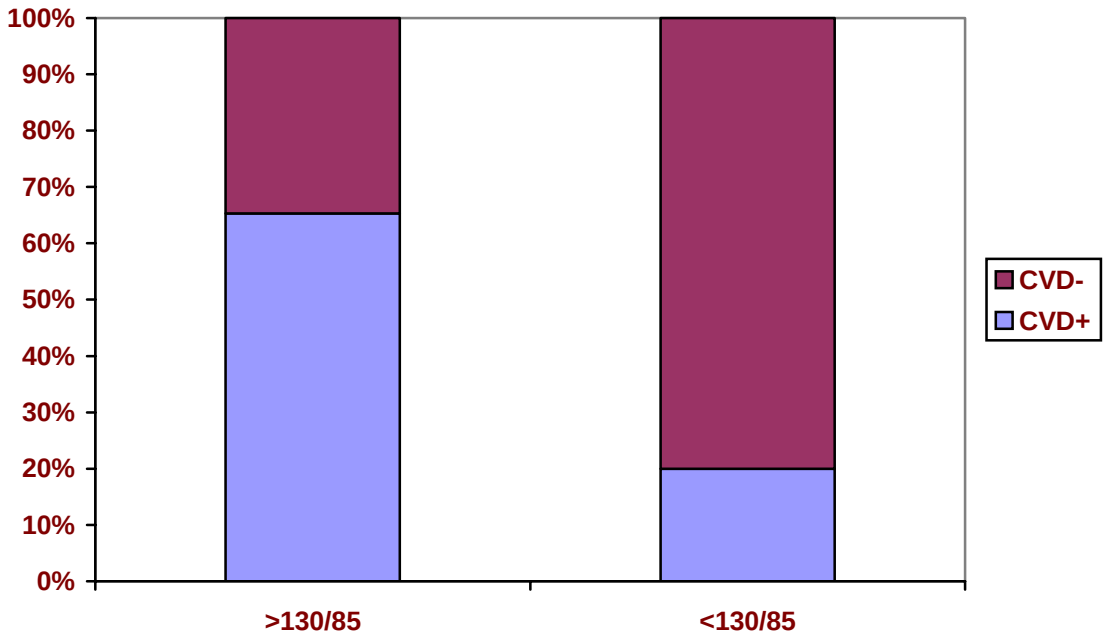


Table 11 : Association of cardiovascular disease with waist circumference in male and female subjects

	MALE		FEMALE	
	> 102 cm	**< 102 cm**	**> 88 cm**	**< 88 cm**
CVD +	**2**	**22**	11	7
CVD -	4	34	7	13
	Q = - 0.128 ; O.R. = 0.77		Q = 0.489 ; O.R. = 2.92	

The association of cardiovascular disease with waist circumference in male and female subjects is explained in Table 11.

In respect of increased waist circumference among the male population, there is no association with cardiovascular disease. The risk of increased waist circumference is very less (Odds Ratio = 0.77). Among females, there is an association of increased waist circumference with cardiovascular disease. The risk of increased waist circumference is 2.92 times.

Fig.10.a. Percentage association of cardiovascular disease with waist circumference (Males)

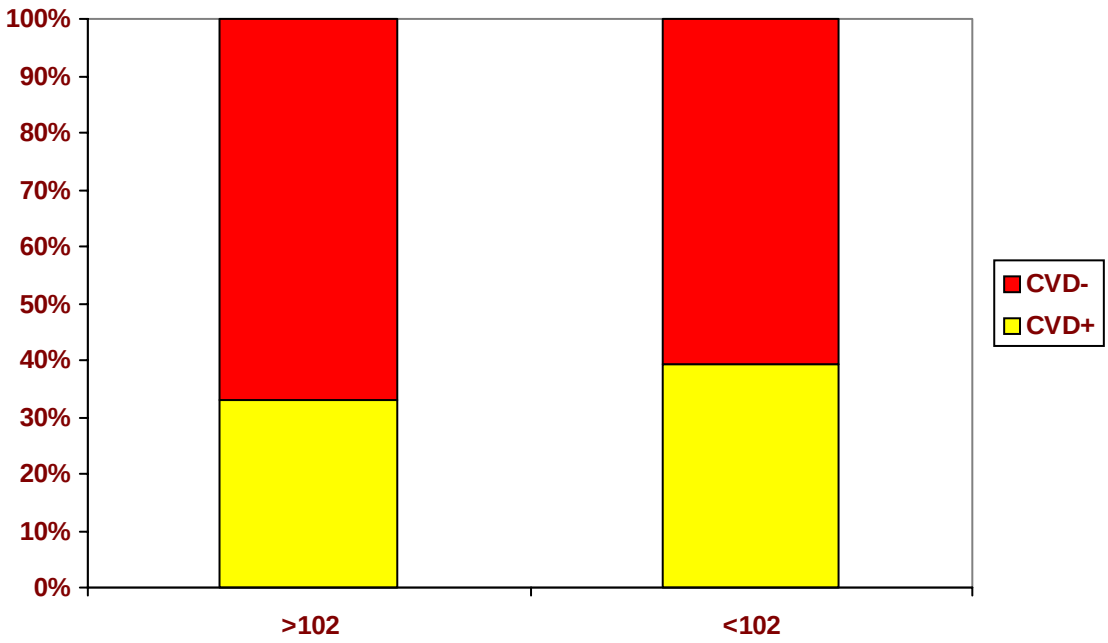


Fig.10.b. Percentage association of cardiovascular disease with waist circumference (Females)

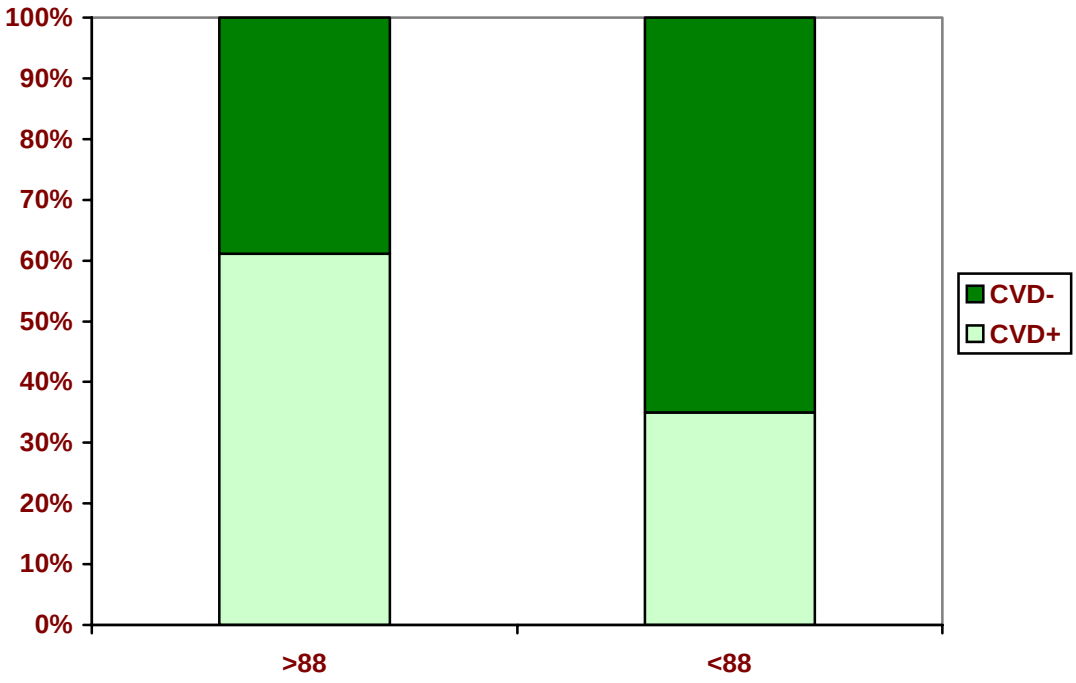


Table 12 : Association of cardiovascular disease with triglycerides in male and female subjects

	MALE		FEMALE	
	≥ 150	**< 150**	**≥ 150**	**< 150**
CVD +	**9**	**17**	12	6
CVD -	20	18	11	9
	Q = - 0.354 ; O.R. = 0.476		Q = 0.241 ; O.R. = 1.6	

In Table 12, details of association between cardiovascular disease and triglyceride levels among male and female subjects are presented.

As seen in Table 12, there is no association of elevated triglyceride levels with cardiovascular disease in male subjects. The risk is less (Odds Ratio 0.476).

In female subjects there is an association of elevated triglyceride levels with cardiovascular disease. The risk of elevated triglyceride level is 1.6 times.

The mean elevated triglyceride level (>150) is 223.3 $\pm$ 76 for males and 251.1 $\pm$ 96.5 for females and the difference is not statistically significant ($p > 0.05$).

Fig.11.a. Percentage association of cardiovascular disease with triglyceride levels (Males)

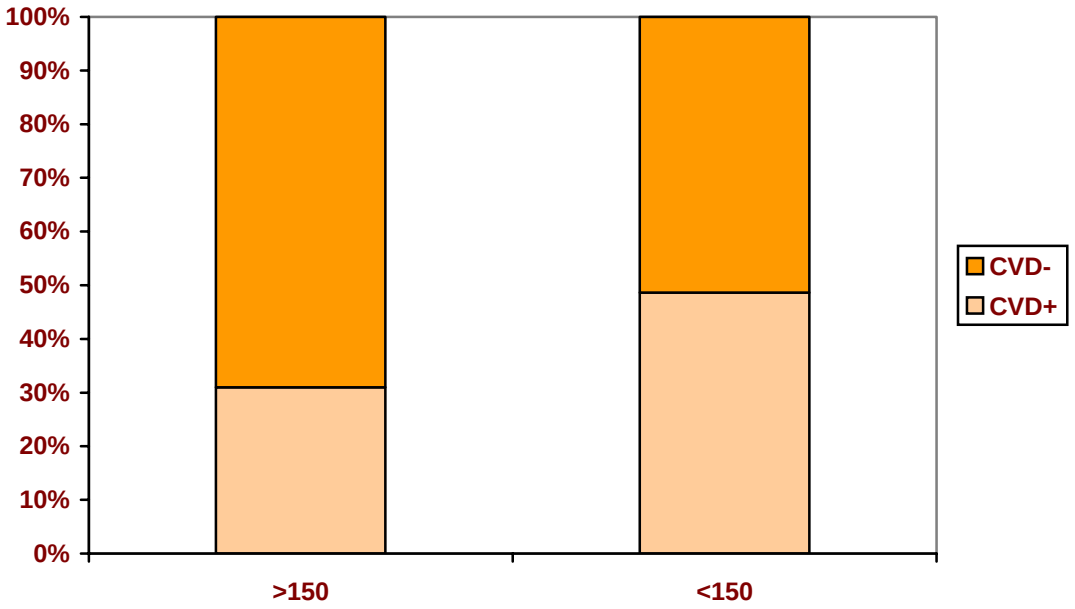


Fig.11.b. Percentage association of cardiovascular disease with triglyceride levels (Females)

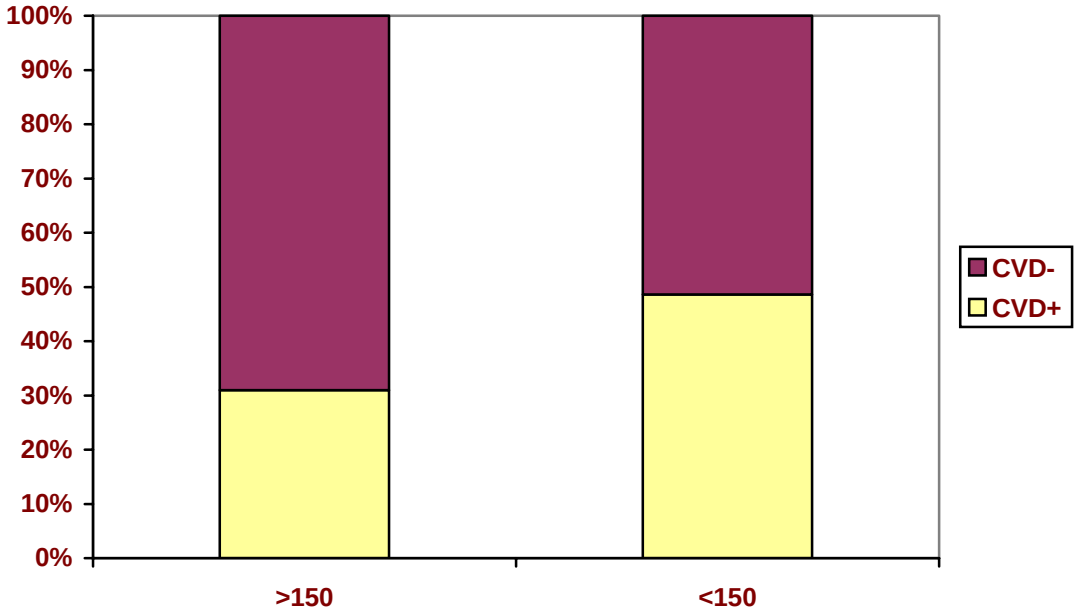


Table 13 : Association of cardiovascular disease with HDL cholesterol levels in male and female subjects

	MALE		FEMALE	
	< 40	**> 40**	**< 50**	**> 50**
CVD +	**13**	**11**	11	7
CVD -	21	17	15	5
	Q = - 0.3125 ; O.R. = 0.52		Q = 0.3 ; O.R. = 0.5	

HDL cholesterol levels in male and female subjects and their association with cardiovascular disease is given in Table 13.

In both male and female subgroups there is no association of low HDL levels with cardiovascular disease (Table 13). The risk of low HDL levels is very less (Males : Odds Ratio = 0.52 and Females : Odds Ratio = 0.5)

Fig.12.a. Percentage association of cardiovascular disease with HDL cholesterol levels (Males)

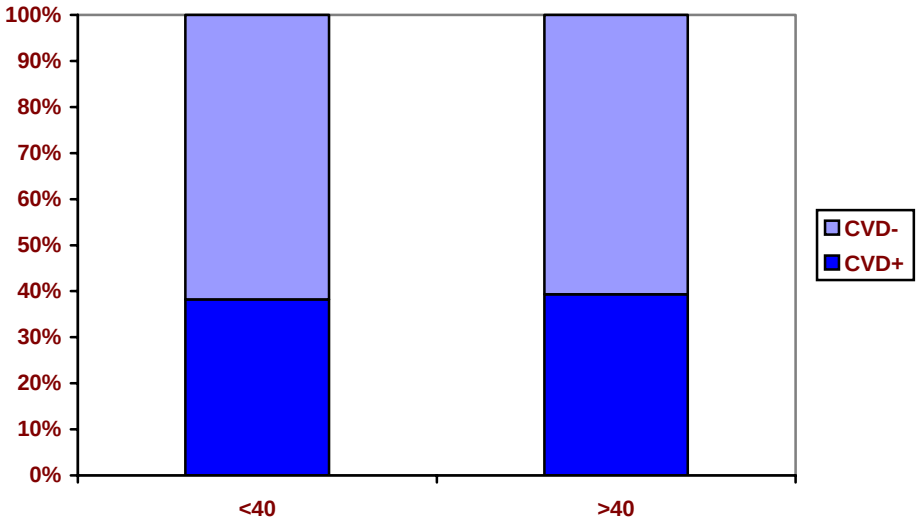
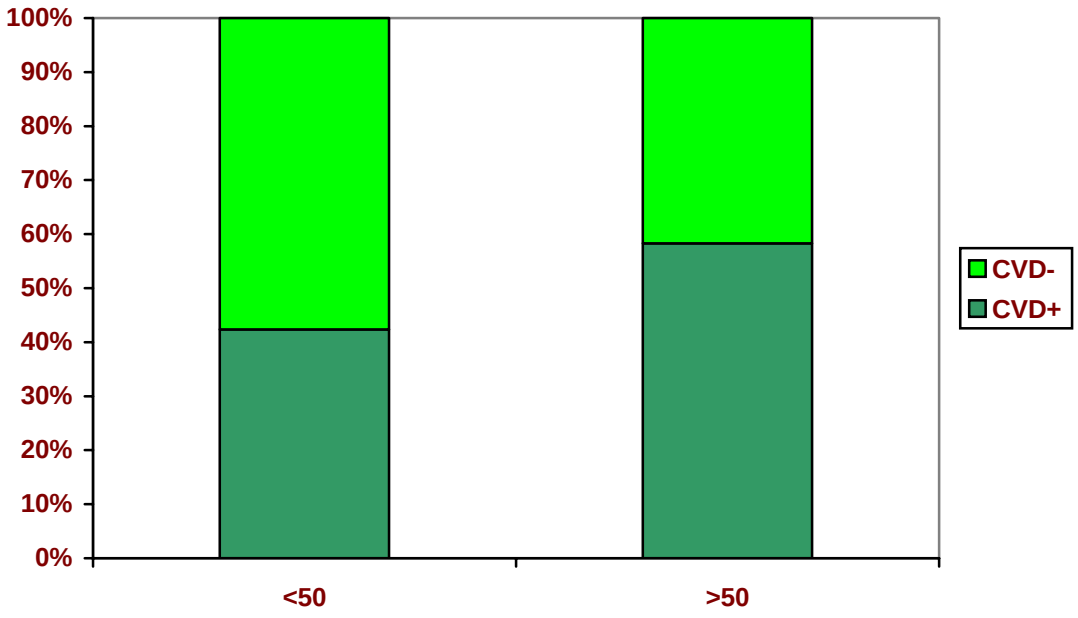


Fig.12.b. Percentage association of cardiovascular disease with HDL cholesterol levels (Females)



DISCUSSION

The current study aimed at finding out the prevalence of metabolic syndrome in subjects with type-2 diabetes mellitus in a population of South Tamilnadu, estimated it to be around 56% based on the NCEP-ATP III guidelines. This is much lower than the prevalence estimated by western workers in the western population where it was in the range of 80 to 85%.[9,10,25]

However, Chee-Eng-Tan et al found the prevalence of metabolic syndrome in subjects with type-2 diabetes mellitus to be around 58% only, when they applied NCEP-ATP III guidelines as such without any modifications to an Asian population[65]. Also, ethnic differences were found to exist between different populations across Asia. Chee-Eng-Tan et al further add that NCEP-ATP III definition of metabolic syndrome when applied to an asian population would not only underestimate the prevalence of metabolic syndrome but, fail to identify many individuals at risk of future cardiovascular disease. This study also observed that there were no sex related differences in the prevalence of metabolic syndrome.

The clinical importance of metabolic syndrome is related to its putative impact on cardiovascular disease morbidity. In this study the risk of association of cardiovascular disease with metabolic syndrome in male subjects was low (O.R.=0.466 and Q= - 0.364) while the risk of association

of metabolic syndrome with cardiovascular disease in female subjects was almost 1.6 times higher.

The lack of association of metabolic syndrome with cardiovascular disease in males in this study could be due to the higher fixed criteria for waist circumference in ATP III guidelines.

The waist circumference criterion probably needs to be reduced to make it a more sensitive predictor of risk association. Sone H et al when after using the modified version of ATP III guidelines with adjusted waist circumference found NCEP definition to be only somewhat predictive of cardiovascular disease in males[62].

On analysing the individual components of metabolic syndrome with the risk of cardiovascular disease in males it was observed that only one of the components namely hypertension was associated to a significant extent (O.R.=1.35 and Q=0.1724). The other components namely central obesity and dyslipidemia were not associated with cardiovascular disease risk in males.

The risk of association of metabolic syndrome with cardiovascular disease in females was high (O.R.=1.6 and Q=0.241). However, the mean age of females with metabolic syndrome than those without were higher

and hence age could possibly be a confounding variable for such an association.

While analysing cardiovascular risk in relation to the different components of metabolic syndrome in females, it was observed that hypertension, central obesity and hypertriglyceridaemia were associated with a higher risk in female subjects. Among these the most significant association was between hypertension and metabolic syndrome in females, the risk being 7.5 times higher.

Further, hypertension was the only individual component consistently associated with risk of cardiovascular disease in both male and female subjects. Similar observations have been made in the Bruneck study[10] which aimed at prospectively evaluating the risk of cardiovascular disease in the form of progressive carotid atherosclerosis and incident coronary heart disease in subjects with metabolic syndrome. They found that hypertension was the only significant independent predictor of incident coronary heart disease, the risk being 3.1 times more.

Finally, it can be said that the use of NCEP-ATP III guidelines in its present form without suitable modifications for our population would largely underestimate the population at risk.

CONCLUSION

The prevalence of metabolic syndrome in subjects with type-2 diabetes mellitus in this study is 56%. The prevalence is comparable with studies conducted in the asian population but less than that in the western population.

Among females, the risk of cardiovascular disease is high (O.R.=1:6 and Q=0.241) in subjects with metabolic syndrome. These females however belong to a higher age group and age was possibly a confounding factor.

In the male subjects there is no significant association of cardiovascular disease with metabolic syndrome (O.R.=0.466 and Q = -0.364).

Systemic Hypertension was the most important individual component of the metabolic syndrome that was associated with an increased risk of cardiovascular disease [(Males: Q=0.1724; OR = 1.35) and (Females : Q=0.764; O.R. = 7.5)] in both sexes.

Dyslipidemia as per the current recommendations of the NCEP ATP III guidelines was not significantly associated with cardiovascular disease.

Central obesity measured by waist circumference was not predictive of cardiovascular disease among males. (O.R.=0.77 and Q=-0.128)

SUMMARY

The prevalence of metabolic syndrome in subjects with type-2 diabetes mellitus is high at 56%, but much less than that in the western population. The NCEP ATP III guidelines were somewhat predictive of cardiovascular disease only in female patients. These female subjects however belong to a higher age group and age was possibly a confounding factor. Hypertension was the only individual component that had a predictive association with cardiovascular disease in both sexes.

Hence, in conclusion it could be said that the NCEP ATP III guideline definition of metabolic syndrome may need to be modified suitably to clearly identify the cardiovascular end points among the diabetic patients in a semi-urban population of South Tamilnadu.

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ANNEXURE - I

PROFORMA

METABOLIC SYNDROME IN SUBJECTS WITH TYPE 2 DIABETES MELLITUS

NAME :

AGE :

SEX :

HOSPITAL No. :

VEGETARIAN ☐ **NON VEGETARIAN** ☐

LITERACY

- **ILLITERATE** ☐
- **SCHOOL** ☐
- **COLLEGE** ☐

OCCUPATION :

ANNUAL INCOME :

ADDRESS :

CLINICAL FEATURES AT THE TIME OF PRESENTATION :

POLYURIA

POLYDYPSIA

POLYPHAGIA

WEIGHT LOSS

UNEXPLAINED FATIGUE

DELAYED WOUND HEALING

LEG ULCERS

TINGLING (OR) NUMBNESS IN EXTREMITIES

PRURITUS VULVAE

VISUAL DISTURBANCES

CHEST PAIN

BREATHLESSNESS

OTHERS (MENTION)

PERSONAL HISTORY :

- **SMOKING** ☐
- **ALCOHOL** ☐

FAMILY HISTORY :

DIABETES MELLITUS ☐

HYPERTENSION ☐

ISCHAEMIC HEART DISEASE ☐

DYSLIPIDEMIA ☐

DRUG THERAPY

STEROIDS ☐

β - BLOCKERS ☐

OTHERS (MENTION) ☐

ON EXAMINATION :

CONSCIOUSNESS
ORIENTATION
TEMPERATURE
PALLOR
CLUBBING
CYANOSIS
PEDAL EDEMA
LYMPHADENOPATHY

PULSE

RATE
RHYTHM
PERIPHERAL PULSES

BLOOD PRESSURE
SITTING (MEAN)
STANDING

HEIGHT
WEIGHT
- **BODY – MASS / INDEX**

WAIST CIRCUMFERENCE
HIP CIRCUMFERENCE
- **WAIST – HIP RATIO**

CARDIOVASCULAR SYSTEM

- **FIRST HEART SOUND**
- **SECOND HEART SOUND**
- **ADDED SOUNDS / MURMUR**

RESPIRATORY SYSTEM :
- **BREATH SOUNDS :**
- **ADDED SOUNDS :**

CNS :
- **FOCAL NEUROLOGICAL DEFICIT (MENTION)**
- **VIBRATION TEST**
- **RHOMBERG'S**

SKIN
FOOT

INVESTIGATIONS :
BLOOD SUGAR
- **RANDOM**
- **FASTING**
- **POST-PRANDIAL**

LIPID PROFILE

BLOOD UREA
SERUM CREATININE

ECG

URINE
- **ALBUMIN**
- **SUGAR**
- **DEPOSITS**

ANNEXURE - II

MASTER CHART

S. No	Name / Hospital No	Age	Sex	Food Habit	Literacy	Occupation	Income	Clinical Feature At Presentation	Family History	S	A	Drug Treatment	Blood Pressure	Ht (cm)	Wt (kg)	BMI	WC	HC	WHR	LIPID TGL	LIPID HDL	BS R	BS F	Metabolic Syndrome +	Metabolic Syndrome -	ECG	TIA / CVA	CVD +	CVD -
1.	Jesudasan (56619)	48	M	NV	C	Teacher	1,00,000	Polyuria	DM (M)	-	-	-	140/ 90	149	54	24. 32	91	95	0.95	209	22	224	112	+		WNL			-
2.	Sivan (46316)	47	M	NV	S	Farmer	5000	Leg ulcer	-	-	+	-	150/100	160	70	27. 34	102	100	1.02	160	54	250	134	+		WNL			-
3.	Backiyathai (45128)	60	F	NV	IL	Housewife	12000	Giddiness	-	-	-	-	150/ 90	155	68	28. 30	115	112	1.02	141	42	334	225	+		WNL			-
4.	Udhuman Muhaideen (47793)	55	M	NV	C	P.W.D	1,20,000	Numbness in Extremities	DM(F)	-	-	-	150/ 90	163	70	26.34	98	102	0.96	89	50	346	211	+		WNL			-
5.	Pathimuthu (44751)	50	F	NV	IL	Housewife	24,000	Giddiness	DM (M) HT (M)	-	-	-	160/ 90	145	62	29.48	102	98	1.04	156	28	213	112	+		WNL			-
6.	Chelladurai (47127)	61	M	NV	S	Salesman	35,000	Unexplained Fatigue	-	-	-	-	140 /90	155	53	22. 06	88	90	0. 97	123	34	220	94	+		Inferolateral wall Ischaemia		+	
7.	Badhar Nisha (454/05)	60	F	NV	IL	Housewife	10,000	Giddiness	-	-	-	-	120/ 90	141	70	35. 21	100	108	0. 92	354	62	247	171	+		OLD IWMI		+	
8.	Joseph (452 / 05)	55	M	NV	S	Factory Worker	12,000	Polyuria	-	+	+	-	110/ 80	165	70	25. 71	92	104	0. 88	199	56	294	235		_	Antero lateral Ischaemia		+	

9.	Pappa (453/05)	45	F	NV	IL	Cottage Industry	2,400	Protracted Vomiting	-	-	-	-	140/ 90	147	50	23. 13	80	95	0. 84	344	46	348	265	+		WNL			-
10.	Abul Hassan (450/ 05)	59	M	NV	S	Madrasa	15,000	Polyuria	DM(F)	-	-	-	140 / 80	155	68	28.30	94	102	0.92	193	72	410	326	+		WNL			-
11.	Velammal (42897)	35	F	NV	S	Housewife	36, 000	Unexplained fatigue	DM (F)	-	-	-	130/ 80	152	67	28. 99	96	108	0. 88	156	70	328	286	+		WNL			-
12.	C. Subbiah (445 / 05)	72	M	V	S	B.D.O	60,000	Giddiness	-	-	-	-	140 / 80	166	79	28. 67	101	104	0. 97	150	38	233	174	+		WNL			-
13.	N. Subbiah (42884)	49	M	NV	S	Bus Conductor	40,000	Multiple Sebaceous cyst	-	-	-	-	110/ 80	170	48	16. 60	99	96	1. 03	339	60	208	238		-	WNL			-
14.	Poovalingam (47110)	55	M	NV	S	Carpenter	12,000	Visual distur bances	-	-	-	-	170/ 90	152	52	22. 50	77	86	0. 89	167	34	308	153	+		WNL			-
15.	Gomathi - ammal (446/05)	65	F	NV	IL	Coolie	10,000	Asympto matic	-	-	-	-	160/ 80	147	54	24.99	86	96	0.91	370	48	293	169	+		WNL			-
16.	Neelakandan (585/05)	49	M	NV	S	Farmer	12,000	Polyuria	-	+	-	-	130/ 90	170	76	26. 29	101	100	1. 01	148	38	287	183	+		WNL			-
17.	Duraipandi (42904)	60	M	NV	IL	Farmer	10,000	Delayed wound healing	-	-	+	-	140/ 90	161	61	23. 53	86	98	0. 87	199	38	453	151	+		Old ASMI		+	
18.	Jeyam Ponnusamy (42593)	53	M	NV	S	Revenue Inspector	1,00,000	Tingling in Extremities	-	-	-	-	120/ 60	158	64	25. 63	91	94	0. 96	146	44	118*	99*		-	WNL			-
19.	Paramasivan (42905)	70	M	V	S	Cycle shop	6,000	Burning Micturition	-	+	-	-	150/ 90	166	63	22. 86	88	91	0. 96	92	32	229	115	+		Inferior wall Ischaemia		+	
20.	Chellammal (42875)	68	F	V	S	Housewife	6000	Polyuria	DM (D)	-	-	-	130/ 80	158	48	19. 22	65	72	0. 90	152	54	395	134		-	WNL			-
21.	Sundari -ammal (41926)	60	F	NV	S	Housewife	18,000	Unexplained Pruritus	-	-	-	-	180/110	151	47	20.61	71	88	0.80	331	40	298	200	+		Old ASMI		+	
22.	Thangabai (42416)	32	F	NV	S	Housewife	10,000	Polydypsia	DM (F)	-	-	-	200/100	148	46	21	81	84	0. 96	129	56	310	177		-	Anterior wall Ischaemia		+	

23.	Chandra sekar (42423)	55	M	NV	S	Cycle rickshaw man	6000	Balano posthitis	-	+	+	-	80 /60	171	54	18. 46	71	83	0. 85	155	20	411	342	+		WNL			-
24.	Rajammal (55472)	70	F	NV	IL	Housewife	12,000	Giddiness	-	-	-	-	220/ 110	139	60	31. 05	97	108	0.89	112	54	239	145	+		Antero lateral ischaemia		+	
25.	Lourd Mary Williams (55741)	66	F	NV	C	Teacher	72,000	Giddiness	DM (F)	-	-	-	160/90	145	63	29. 96	99	101	0.98	266	32	264	123	+		Old ASMI		+	
26.	Chandra sekhar (57011)	65	M	V	S	Clerk	84,000	Asympto matic	DM, HT (F)	-	-	-	110/ 70	158	67	26. 83	91	94	0. 96	171	30	211*	112*	+		WNL			-
27.	Sudalai Muthu (56593)	56	M	NV	S	Farmer	6000	Leg ulcer	-	-	-	-	170/ 100	158	61	24. 43	92	92	1	171	24	253	172	+		WNL			-
28.	Karthikeyan (56545)	47	M	NV	C	Clerk	18000	Unexplained Fatigue	DM (F)	-	-	-	100/80	160	80	31.25	95	107	0. 88	260	38	225	130	+		Old AWMI		+	
29.	Krishnan (56719)	50	M	NV	S	Contract Worker	18000	Delayed wound healing	-	+	+	-	150/ 110	164	73	27.14	96	99	0. 96	117	32	241	157	+		Lateral wall Ischaemia		+	
30.	Gurusamy (56569)	45	M	NV	S	Security Guard	18000	Giddiness	-	-	-	-	130/ 90	151	70	30.7	94	97	0. 96	135	46	314	274		-	Inferior wall Ischaemia		+	
31.	V.Jagan nathan (56859)	64	M	NV	S	Driver	12000	Asypmto matic	-	-	-	-	120/ 90	162	58	22. 10	90	93	0. 96	164	50	381*	267		-	Inferior wall Ischaemia		+	
32.	Maria chellathai (42017)	71	F	NV	IL	Housewife	24,000	Polyuria	-	-	-	-	130/ 70	146	48	22.51	101	91	1. 10	134	34	315*	248	+		WNL			-
33.	Venkata chalam (40859)	70	M	NV	S	Textile worker	12000	Unexplained Fatigue	-	+	+	-	146/ 90	168	62	21. 95	91	87	1. 04	150	24	210	126	+		Left Atrial enlargement +			-
34.	Chandra sekhar (42554)	52	M	NV	S	Musician	12000	Chest pain	-	+	+	-	110 /80	153	48	20. 50	76	81	0. 93	108	38	205	130		-	IWMI		+	
35.	Ulaganathan (41665)	45	M	NV	S	Biller, Ration Shop	36000	Polyuria	-	+	+	-	140/ 90	163	66	24. 84	90	88	1. 02	90	38	161*	118*	+		Low Voltage Complex			-
36.	Pitchai mydeen (41602)	58	M	NV	S	Co-operative	12000	Breathless ness	-	+	-	-	130 / 100	165	76	27. 91	102	99	1. 03	60	54	163*	111*		-	LBBB		+	

37.	Jansi (40078)	55	F	NV	IL	Housewife	36000	Chest pain	-	-	-	-	120/ 80	160	58	22. 65	85	90	0.94	167	50	380	132		-	Antero septal Ischaemia		+	
38.	Ganapathy (1177)	59	M	NV	S	Farmer	10,000	Leg ulcer	-	-	-	-	150/ 90	162	71	27. 05	99	99	1.00	140	64	220*	105*		-	Inferior wall Ischaemia		+	
39.	Jameela (52253)	47	F	NV	IL	Beedi Worker	6000	Bilateral pedal edema	-	-	-	-	110 /70	148	43	19.63	71	86	0.82	130	58	276	222		-	LAHB, VPB Anterior Wall Ischaemia		+	
40.	Kavitha (52610)	40	M	NV	S	House wife	12000	Unexplained Fatigue	-	-	-	-	160 / 90	148	54	24. 65	91	100	0.91	122	70	231	128		-	WNL			-
41.	Chandra Balan (51741)	54	M	NV	S	Factory Worker	12000	Tingling Extremities	-	+	-	-	140/70	158	62	24.83	88	97	0. 90	162	30	250	128	+		WNL			-
42.	Ganesan (52969)	40	M	NV	S	KTC Agent	18000	Stroke	DM (M)	-	-	-	110/70	161	51	19.67	79	89	0. 88	140	64	310	248		-	Right Hemi -paresis		+	
43.	Backiya nathan (57664)	63	M	NV	S	Mill worker	6000	Giddiness	-	-	-	-	120/80	171	99	33 .85	109	114	0.95	351	35	311	266	+		WNL			-
44.	Veluchamy (39889)	57	M	NV	S	Tea Estate Worker	30000	Fatigue	-	-	-	-	130/80	160	51	19.92	83	89	0. 93	171	25	355	200	+		Old AWMI, IWMI & Lateral wall Ischaemia		+	
45.	Rajagopala Devar(39062)	65	M	NV	IL	Farmer	18000	Cough	-	+	+	-	130 /80	168	47	16.65	77	85	0.90	100	28	305	218		-	WNL			-
46.	Subhiah (40080)	55	M	NV	S	Farmer	12000	Chest pain	-	-	-	-	120/ 80	161	50	19.76	72	81	0.88	126	25	208	171		-	WNL			-
47.	Raja(39523)	60	M	NV	S	Railway line worker	12000	Chest pain	-	+	-	-	130 / 80	172	60	20.28	98	98	1	113	34	230	132		-	RBBB, LAHB Anterior Wall Ischaemia		+	
48.	Dharmambal (39838)	75	F	V	S	Housewife	6000	Cough	IHD (B)	-	-	-	100/ 70	142	58	28.76	92	102	0.9	485	46	270	201	+		IWMI		+	
49.	Pandyan (37134)	50	M	NV	S	Driver	18000	Breath-lessness	-	+	+	-	100/ 70	152	45	19.47	77	82	0. 93	91	58	477	181		-	Lateral wall Ischaemia		+	
50.	Poova konar (39814)	46	M	NV	S	Farmer	6000	Jaundice	HT (F)	-	-	-	130 /90	174	92	30.38	112	112	1	139	24	315	180	+		WNL			-

51.	Jayamani (39744)	62	F	NV	S	Housewife	12000	Giddiness	-	-	-	-	120/ 80	146	45	21.11	88	92	0. 95	213	60	578	409		-	WNL			-
52.	Chelladurai (40115)	50	M	NV	S	Merchant	9000	Weakness	-	-	-	-	120/ 80	177	68	21.70	83	87	0.95	153	40	208	128		-	Left Hemi-paresis		+	
53.	Swamydoss (40598)	65	M	NV	S	Merchant	18000	Giddiness	-	+	-	-	110/ 80	150	50	22.22	94	86	1.09	188	82	385	136		-	WNL			-
54.	Sahul Hameed (39813)	55	M	NV	S	Driver	12000	Leg ulcer, Visual Disturbance	-	-	-	-	110/ 80	164	75	27.88	94	96	0.97	117	34	277*	131*		-	Antero Lateral Ischaemia		+	
55.	Arjunan (40016)	59	M	NV	S	Rtd. Jail Supdt.	36000	Stroke	-	-	-	-	140 / 96	162	65	24.77	86	91	0.94	190	50	196*	122*	+		Lateral wall Ischaemia / Stroke		+	
56.	Chinna Karuppa samy (40494)	55	M	NV	S	Farmer	24000	Leg ulcer	-	+	-	-	90/60	158	45	18.02	76	82	0.92	94	22	243	129		-	WNL			-
57.	Chandra sekar (42172)	65	M	V	S	Watchman	12,000	Polyuria	-	+	-	-	180/110	153	58	24.77	99	99	1	127	70	210	171		-	LVH,Lateral wall ischaemia		+	
58.	Arumugam (42479)	58	M	NV	IL	Tailor	24000	Tingling Extremities	-	-	-	-	180/110	150	40	17. 77	72	80	0.9	140	38	216	121	+		Right Axis Deviation			-
59.	Md. Alibaba (42501)	53	M	NV	IL	Tea stall (Master)	24000	Weight loss	-	+	+	-	110/80	164	50	18. 81	82	87	0.94	102	34	315	131		-	Right Axis Deviation			-
60.	Chinna samy (42476)	55	M	NV	IL	Carpenter	12000	Delayed wound healing	-	+	+	-	160 / 100	163	65	24. 46	82	89	0.92	141	20	201	111	+		Lateral wall Ischaemia		+	
61.	Vallithai (52744)	50	F	NV	IL	Farmer	5000	Leg Ulcer	-	-	-	-	100/ 80	147	40	18. 59	62	82	0.75	142	20	252	197		-	WNL			-
62.	Abdul Majid (38861)	45	M	NV	S	Driver	12000	Giddiness	DM (F)	-	-	-	100/ 80	163	66	24. 84	92	95	0.96	309	46	258	146		-	WNL			-
63.	Krishn -ammal (38897)	50	F	NV	S	Farmer	10000	Giddiness	DM (M)	-	-	-	100/ 60	141	39	19. 61	69	85	0.81	140	24	471	201		-	WNL			-
64.	Abdul Kadar (28660)	60	M	NV	S	Plastic shop Merchant	12000	Polyuria	-	-	-	-	140/70	158	53	21. 23	112	109	1.02	310	46	249	131	+		Old IWMI		+	

65.	**Ramadass (542/05)**	**71**	**M**	**NV**	**S**	**Cobbler**	**6000**	**Chest pain**	**DM (F)**	**-**	**-**	**-**	**140 /70**	**149**	**50**	**22. 52**	**84**	**84**	**1**	**185**	**44**	**352 264**	**+**		**WNL**			**-**
66.	**Ponmani (540/05)**	**57**	**F**	**NV**	**S**	**Housewife**	**50000**	**Visual Disturbance**	**-**	**-**	**-**	**-**	**140/ 86**	**156**	**72**	**29. 58**	**96**	**112**	**0. 85**	**201**	**28**	**296 157**	**+**		**Inferior, Anterior wall Ischaemia**		**+**	
67.	**Ganapathy (57682)**	**78**	**M**	**V**	**S**	**Farmer**	**12000**	**Polyuria**	**-**	**-**	**-**	**-**	**130 /70**	**163**	**55**	**20.7**	**83**	**86**	**0. 96**	**80**	**54**	**211* 111***		**-**	**RBBB**			**-**
68.	**Pappa (53524)**	**45**	**M**	**NV**	**S**	**Salesman**	**18000**	**Polyuria**	**DM (F)**	**-**	**-**	**-**	**110 / 80**	**156**	**60**	**24.65**	**69**	**63**	**1.09**	**99**	**26**	**245 160**		**-**	**WNL**			**-**
69.	**Ganesan (45372)**	**57**	**M**	**NV**	**S**	**Sugar Factory worker**	**6000**	**Un-explained fatigue**	**-**	**-**	**-**	**-**	**130/100**	**150**	**50**	**22.22**	**80**	**88**	**0.90**	**74**	**38**	**380 572**	**+**		**WNL**			**-**
70.	**Dharmalinga Nadar (44858)**	**65**	**M**	**NV**	**S**	**Depart mental Stores**	**12000**	**Chest pain**	**-**	**-**	**+**	**-**	**130 / 90**	**160**	**60**	**23.43**	**92**	**92**	**1**	**141**	**60**	**240 130**		**-**	**Old ASMI**		**+**	
71	**Selvin (59571)**	**60**	**M**	**NV**	**S**	**Madura coats labourer**	**24000**	**Balano posthitis**	**DM (F, D)**	**-**	**-**	**-**	**110/70**	**160**	**75**	**29.29**	**101**	**101**	**1**	**163**	**52**	**230 115**		**-**	**WNL**			**-**
72	**Esuvadayan (44950)**	**54**	**M**	**NV**	**S**	**Fisherman**	**6000**	**Un explained Fatigue**	**-**	**+**	**+**	**-**	**130/90**	**160**	**48**	**18.75**	**71**	**71**	**1**	**101**	**72**	**239 146**		**-**	**WNL**			**-**
73	**Susheela (61510)**	**50**	**F**	**V**	**S**	**Farmer**	**12000**	**Polyuria**	**-**	**-**	**-**	**-**	**110/80**	**152**	**45**	**19.47**	**78**	**80**	**0.97**	**262**	**50**	**219 220**		**-**	**WNL**			**-**
74	**Sandhana Sundhari (1708/05)**	**47**	**F**	**NV**	**S**	**Housewife**	**12000**	**Vitiligo**	**-**	**-**	**-**	**-**	**120/80**	**145**	**70**	**33.29**	**109**	**109**	**1**	**117**	**55**	**260 179**		**-**	**WNL**			**-**
75	**Arunachalam (30469)**	**70**	**M**	**V**	**IL**	**Coolie**	**10000**	**Fatigue**	**-**	**-**	**-**	**-**	**110/70**	**150**	**45**	**20**	**80**	**86**	**0.93**	**147**	**68**	**399 130**		**-**	**WNL**			**-**
76	**Indira (61506)**	**55**	**F**	**V**	**S**	**Housewife**	**18000**	**Polyuria**	**-**	**-**	**-**	**-**	**110/70**	**140**	**40**	**20.4**	**74**	**84**	**0.88**	**141**	**42**	**230 118**		**-**	**WNL**			**-**
77	**Abdul Salam (35482)**	**35**	**M**	**NV**	**S**	**Cook**	**12000**	**Weakness of right extremities**	**-**	**-**	**-**	**-**	**130/90**	**162**	**62**	**23.62**	**86**	**90**	**0.95**	**130**	**54**	**240 126**		**-**	**Right hemiparesis**		**+**	
78	**Mohammed Ibrahim (44487)**	**65**	**M**	**NV**	**S**	**Cleric**	**6000**	**Fatigue**	**-**	**-**	**-**	**-**	**146/80**	**158**	**60**	**24.03**	**84**	**88**	**0.95**	**74**	**26**	**318 227**	**+**		**Old IWMI**		**+**	

79	Subbulakshmi (44728)	61	F	NV	S	Housewife	7500	Tingling extremities	DM (S)	-	-	-	170/110	143	67	32.76	104	107	0.97	185	34	245	153	+		Old ASMI		+	
80	Pookani (58806)	43	F	NV	S	VHN	48000	Polyuria	DM (M)	-	-	-	100/70	151	52	22.80	89	99	0.89	81	36	240	133	+		Old ASMI		+	
81	Saraswathi (57201)	60	F	V	S	Housewife	12000	Polyuria	DM (M, B) HT (M)	-	-	-	150/90*	142	55	27.27	87	99	0.87	221	36	305	161	+		WNL			-
82	Saroja (57228)	53	F	NV	IL	Housewife	60000	Pruritus vulvae	-	-	-	-	170/90	144	80	38.58	105	115	0.91	337	16	235	140	+		Anterolateral Ischaemia		+	
83	Annammal (57357)	52	F	NV	S	Housewife	24000	Pruritus vulvae	DM (B)	-	-	-	130/70	141	57	28.67	84	90	0.93	165	50	370	267		-	Inferior wall Ischaemia		+	
84.	Eswarath-ammal (58190)	50	F	V	IL	Cottage Industry	18000	Unexplained vomiting	-	-	-	-	120/70	143	50	24.45	84	94	0.89	187	46	390	310	+		WNL			-
85	Rama chandran (58559)	65	M	NV	S	Watchman	10000	Polyuria	-	-	-	-	120/80	162	65	24.76	96	90	1.06	103	26	357	140		-	WNL			-
86	Murugan (58795)	40	M	V	S	Hotel Supplier	12000	Polyuria Visual Disturbance	DM (M, B)	-	-	-	140/90	165	75	27.54	105	106	0.99	97	24	311	227	+		WNL			-
87	Mydeen Fatima (45014)	45	F	NV	S	Beedi worker	6000	Breath lessness	-	-	-	-	140/80	138	48	25.2	85	87	0.97	125	16	201*	114*	+		Sinus tachycardia			-
88.	Vallithai (58213)	56	F	NV	S	Housewife	24000	Vomiting	-	-	-	-	170/100	140	50	25.1	90	98	0.91	194	30	237	120	+		Old IWMI Anterolateral Ischaemia		+	
89	Alagu Rathinam (57195)	56	M	NV	S	Driver	1,10,000	Unexplai-ned fatigue	DM (F,M)	-	-	-	140/90	163	74	27.85	98	98	1	172	34	233	149	+		WNL			-
90	Gomathi (45002)	65	F	V	IL	Small scale Industry worker	10,000	Polyuria	-	-	-	-	150/100	148	54	24.65	102	102	1	181	24	270	188	+		Lateral wall Ischaemia		+	
91	Farida Begum (590/05)	47	M	NV	S	House wife	36000	Weight loss	-	-	-	-	140/110	153	70	29.9	98	112	0.87	404	30	255	151	+		WNL			-
92	Josephine (56842)	65	F	NV	S	House wife	12000	Giddiness	-	-	-	-	140/90	150	45	20	76	83	0.91	198	22	324	210	+		WNL			-

93	Rajammal (57231)	60	F	NV	S	House wife	12000	Giddiness	-	-	-	-	156/110	142	66	32.73	102	113	0.90	240	42	232	129	+		Lateral wall Ischaemia		+	
94	Murugan (57162)	50	M	NV	C	Panchayat clerk	24000	Polyuria	-	-	-	-	120/90	158	76	30.44	99	103	0.96	357	20	245	140	+		WNL			-
95	Muthammal (36656)	45	F	NV	IL	House wife	18000	Leg ulcer	-	-	-	-	110/80	163	44	16.56	76	82	0.92	102	16	261	138		-	WNL			-
96	Avudayappan (1457/05)	45	M	NV	S	Market coolie	18000	Stricture urthera	-	-	-	-	130/90	157	90	36.51	107	113	0.94	158	22	273	159	+		WNL			-
97	Poovammal (468/05)	57	F	NV	S	House wife	12000	Polyuria	-	-	-	-	120/80	156	58	23.83	100	96	1.04	464	16	209	130	+		WNL			-
98	Saraswathi (472/05)	60	F	NV	S	House wife	4000	Fatigue	-	-	-	-	120/80	144	50	24.11	84	86	0.97	110	56	223	112		-	Inferior wall Ischaemia		+	
99	J. Rosemary (10655)	52	F	NV	S	Tailor	5000	Dental caries	-	-	-	-	130/80	154	55	23.19	85	100	0.85	130	54	301	239		-	Lateral wall Ischaemia		+	
100	Petchiammal	55	F	NV	S	House wife	12000	Asymptomatic	-	-	-	-	120/80	145	50	23.78	84	95	0.88	140	45	279	248		-	WNL			-

Sex : M - Male, F - Female

Literacy : C - College, S – School, IL - Illiterate

Family History : F – Father, M – Mother, B – Brother, S – Sister

Personal History S – Smoker, A – Alcoholic

Ht – Height
Wt – Weight
BMI – Body Mass Index

WC – Waist circumference
HC – Hip circumference
WHR – Waist Hip Ratio

Food Habit : V – Vegetarian, NV – Non Vegetarian

BS – Blood Sugar
R – Random
F – Fasting

CVD – Cardiovascular (Coronary / Cerebro vascular) events
TIA – Transient Ischaemic attack
CVA – Cerebro vascular accident

ECG : Electro Cardiogram
WNL – Within normal Limits
ASMI – Antero septal myocardial infarction
IWMI – Inferior wall myocardial infarction
AWMI : Anterior Wall myocardial infarction

LBBB – Left Bundle Branch Block
LAHB – Left Anterior Hemi Block
LVH : Left Ventricular Hypertrophy
VPB - Vaentricular premature beat